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ABSTRACT

This document contains the following full and short papers on policies, ethics, standards, and legal issues from ICCE/ICCAI 2000 (International Conference on Computers in Education/International Conference on Computer-Assisted Instruction): (1) "A Study on the School Information Technology Pilot Scheme: Possibilities of Creative and Lifelong Learning" (Siu-Cheung Kong, Wing-Kee Au, and Sai-Wing Pun); (2) "Health Risks with Computer Use in New Zealand Schools" (Kwok-Wing Lai); (3) "Information Technology Competency for Hong Kong Teachers--A New Era and a New Paradigm" (Wing Kee Au, Siu Cheung Kong, Kin Ping Leung, Eugenia Mee Wah Ng, and Sai Wing Pun); (4) "Present State and Future Direction of Woman Informatization Education in Korea" (In-Hwan Yoo, Chul-Hyun Lee, Soo-Bum Shin, and Tae-Wuk Lee); (5) "Space Plan for Effective Educational Software Utilization in Korea" (Soo-Bum Shin, Chul-Hyun Lee, In-Hwan Yoo, and Tae-Wuk Lee); and (6) "Using Learning Object Meta-Data in a Database of Primary and Secondary School Resources" (Daniel D. Suthers). (MES)

ICCE/ICCAI 2000 Full & Short Papers (Policies, Ethics, Standards, and Legal Issues)

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A Study on the School Information Technology Pilot Scheme: Possibilities of Creative and Lifelong Learning

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The Hong Kong Special Administration Region (HKSAR) Government is promoting the use of Information Technology (IT) in education for creative and lifelong learning. A two-year IT-pilot scheme has been launched among 10 primary schools. The first phase of the current study had reported on the planning and implementation of the schools in the first year of the scheme. This paper reports findings from the second year. All 10 primary schools are studied by a case-study approach. This phase aims to investigate the effect of using IT in learning and teaching. Data were collected via browsing web sites, visits and interviews. The research results show that some schools are optimizing students' opportunities for accessing the computing and networking capabilities. Acquiring a LCD projector in each general classroom is an important part of the IT infrastructure for promoting the use of IT in schools. All schools are motivating teachers to use IT to improve the traditional mode of learning and teaching by developing multimedia-teaching unit. Schools need to develop teachers' sense of harnessing technology for rethinking and redesigning educational practice through staff development. It is speculated that school policy plays a crucial role in promoting the paradigm of creative and lifelong learning.

Keywords: **IT in education, lifelong learning, school policy**

1 Introduction

Within the nine-year compulsory education system in Hong Kong, students have to learn in large groups with very few choices of school curriculum. Teachers have to teach more or less the same subject knowledge specified in the formal curriculum and approved textbooks. Chances for learners to keep in contact with the real life experiences were limited. Cheng [1] points out that this kind of learning from traditional school experience is an isolated mode of learning. Perelman [2] further argues that such kind of educational management operated by the government is similar to the socialism planning economy mode of operation. It can be surmised that curricular contents and instructional methods that are structured and rigid do not really cater for the needs of learners in the information era. These arguments indicate that the traditional school education system is seriously "disconnected" from the information society. Contents learnt from school education can rarely be used in real life. In this context, the Hong Kong Special Administration Region (HKSAR) government is promoting the use of Information Technology (IT) in education for creative and lifelong learning to cope with the rapid changes in contemporary society [3, 4, 5, 6]. A document on the reform proposals of the education system review of the HKSAR government stated its vision as follow:

Students are the focus of the whole education reform. **The basic premise is to enable every individual to pursue all-round development through lifelong learning.**... However, in tandem with changes taking place in the community, our students' learning needs have also changed. It is essential or our education system, including its academic structure, content and modalities, to be duly adjusted in response to these changes [6,

p.4].

A two-year IT-pilot scheme was launched in September 1998 for 10 primary schools and 10 secondary schools. These pilot primary schools, with the support of US$480 000 from the government, were expected to experiment with integrating IT in learning and teaching with a resultant change in the paradigm of learning and teaching which may empower both the learners and the teachers. A study on the planning and implementation of the first year of the scheme in nine primary pilot schools was conducted by using a case-study approach and the results were reported [7, 8]. This paper reports the second phase of this study. During the second-phase study, the research team revisited the schools and aimed at investigating the changes in the mode of learning and teaching of the pilot schools experienced in the second year of the scheme after the implementation of the IT infrastructures in the first year of the scheme.

There are various kinds of models, which attempt to conceptualise the integration of technology into learning and teaching, for example, the Concern-Based Adoption Model (CBAM), the Planning Process Models (PPM) and the Technology Maturity Model (TMM) [9, 10, 11]. CBAM serve as a diagnostic tool for the technology integration planning and implementation by studying the stages of concerns of the planners. CBAM considers developing items in different stages of the integration plan. It better suits longitudinal research. PPM provides general guidelines on the planning process that emphasizes on establishing a comprehensive administrative framework for the technology integration plans and the planning must address the local situation. PPM is especially designed for setting up a well-organized administrative structure and ensuring the implementation of the plan. PPM focuses on the study of a particular school. TMM mainly evaluates the depth of integration of IT with education through observation, such as school planning and implementation of IT in learning and teaching. It also concerns the daily use of IT in school and studies the effectiveness. TMM is appropriate for the study of the implementation of IT in education of several schools for identifying favourable factors or obstacles.

The framework of this study is derived from the guidelines of TMM. Five main items of the model are selected for detailed study. They are student use, teacher use, curriculum integration, staff development, and school policy. This research will report on the daily use of IT in learning and teaching and will discuss the effectiveness of integration. IT in education is developing at its initial stage in Hong Kong. Schools have limited experiences on integrating IT in education. The experiences of pilot schools can be a useful reference for most of the schools intending to integrate IT into learning and teaching. The findings of the study will be important for promoting the use of IT for creative and lifelong learning in Hong Kong.

2 Research Question

The first phase of the study had reported on the planning and implementation issues in the first year of the scheme. Nine pilot primary schools were studied. This study is the second phase of the research and all 10 IT pilot primary schools participates. During this phase, the research team re-visited the nine schools and also visited the one missed in the first phase. The aim of the study is to further investigate the pilot schools' use of IT and to obtain an in-depth knowledge profile of the schools' integration of IT into the curriculum. The core research question of the study is to investigate the changes introduced by the use of IT in learning and teaching with particular reference to the five selected items in the framework of the study [12, 13]. In this regard, two subsidiary research questions are explored.

1. How does IT improve the traditional learning and teaching paradigm?
2. How learning can be enhanced for the emerging paradigm of creative and lifelong learning in the information era when learners are empowered by IT?

3 Research Methodology

A case-study approach was adopted in this research in order to obtain the in-depth profile of the pilot schools relating to the implementation of IT in education [14]. Data were collected via browsing school web sites; school visits and interviews. Table 1 shows the web sites of all pilot primary schools in Hong Kong.

Table 1: Web sites of all pilot primary schools in Hong Kong and number of visitors as at the 16, May 2000

URL	Visitors	URL	Visitors
http://www.buddhist-wingyan-sch.edu	No counter	http://kws.hkcampus.net/	No counter

.hk/			
http://bwcss.school.net.hk/	40200	http://www.lkw.edu.hk/	1951
http://am.npgps.edu.hk/	No counter	http://www.tpomps.edu.hk/	123453
http://plklht.school.net.hk/	72984	http://www.ychchtps.edu.hk/	No counter
http://www.pm.plkhsn.edu.hk/	28126	http://www.skhsjs.edu.hk/	No counter

Samples of lessons plans of teachers and students' work were also collected [15]. These data were organised and interpreted according to the framework of the study. During the school visits, interviews and site visits to all IT facilities of the schools were conducted. The interviewees included school principals and IT coordinators. In all, ten school principals or deputy principals and five IT coordinators were interviewed.

4 Results and Discussions

The initial research result of this phase of study shows that schools are struggling for offering opportunities to students for creative and lifelong learning by different approaches. This section will report on the development or changes of the pilot schools observed in the second phase of the study on the five selected items. They are students' use of IT for learning, teachers' use of IT for teaching, integration of IT in the curriculum, staff development and school policy.

4.1 Students' Use

All ten pilot schools offered Computer Awareness Programme (CAP). This programme provided software operation skills and basic IT knowledge to students. Nine schools scheduled these programmes in regular lessons. One school infused the awareness programme contents in various subjects according to the nature of the content. For example, spreadsheet was taught in mathematics lessons and word processing and email were integrated in English lessons. Results of the first-phase study indicated most students in the pilot schools might access to the computers only once or twice a week in the computer awareness lessons [7, 8]. Students could use computers before or after school hours, recesses or lunch breaks but students' use was infrequent in the first phase. There is a change observed during the site visits of the second-phase study. Students had access freely to the computing and networking facilitates around the environment of some schools. Table 2 shows the location of free access to computing and networking facilities for students in the pilot schools. Schools with more free access locations for students are put towards the right-hand-side of the table.

Table 2: Location of free access to computing and networking facilities for students in pilot schools

Location of Access	School 1	School 2	School 3	School 4	School 5	School 6	School 7	School 8	School 9	School 10
Classroom Computers			✓				✓	✓	✓	✓
Computer Classrooms		✓		✓	✓	✓			✓	✓
Library Computers	✓			✓	✓		✓	✓	✓	✓
Corridor Computers						✓				✓

There were computers free to use in the general classrooms, computer classrooms, libraries and the corridors. According to the figures estimated from the pilot schools, the home computing access rate ranged from 30 to 60 percent. Therefore free access of computing and networking facilities become an important tool to achieve equity and to promote a school culture of using IT to learn and teach. On average, there were 1.8 computer classrooms in the ten pilot schools. Sixty percent of the schools arrange their computer rooms for students' access besides scheduled classes. Seventy percent of the schools provide 3 to 10 computers in the library for drop-in access. Half of the schools admitted students to use computers in general classrooms. The number of classroom computers ranged from 1 to 4. It was interesting to note that some pilot schools even allowed students to share the only classroom computer with the teachers. All pilot schools allowed students to explore freely on the World Wide Web (WWW) except some of them used filters to bar access to pornographic sites. It could be speculated from the site visits that optimising students' free access opportunities might provide a solid foundation for creative use of the computing and networking capabilities and hence might nourish skills and processes that could support learning as a lifetime habit [16].

4.2 Teachers' Use

A teacher may need to deliver curricular contents in the traditional paradigm of learning and teaching. A teacher may serve as a learner's counsellor, a coach and a facilitator who extends the intelligence of the students by helping them in the emerging paradigm of creative and lifelong learning in the information era [16]. No matter with which paradigm teachers are working, there are chances that learners and teachers need to share and communicate. The existing class structure as learning group requires support to facilitate such sharing and communication in the general classroom. There is preparation work for teachers to carry out their roles using the computing and networking facilities of general classroom.

Three kinds of technical installation modes were reported in the first phase of the study [7, 8]. They are: TV connection, fixed LCD, and mobile LCD. TV connection needs a TV connector to connect the classroom computer and the classroom TV for display. TV sets are standard equipments in general classrooms. Fixed LCD set up requires the setting up of a ceiling-mounted classroom LCD projector for projection but there is no set up work during routine use. Mobile LCD set up requires the transportation of LCD projector for on-site setting. Some schools provide desktop computer in general classroom while the other provide school notebook computers. Teacher needs to obtain both a projector and a computer to conduct class presentation in general classroom. Table 3 summarizes the number of schools by mode of projection preparation and by type of classroom computer.

Table 3: Number of schools by mode of projection preparation and by type of classroom computer

Type of Classroom Computer	TV Connection	Mobile LCD	Fixed LCD
Provide Notebook Computer for Classroom Use	1	3	1
Provide Classroom Desktop Computer	1	1	3

All schools in the pilot scheme provided computing and projection facilities for class use in general classrooms. Teachers could use the facilities to deliver teaching contents through the projection screens or TV sets. Teachers could also conduct interactive teaching by retrieving multimedia teaching units from the Intranet or browsing teaching resources from the Internet. Students could use the facilities to present their project work to their classmates and teachers.

Results of the first phase study indicated that teachers of the pilot schools used the IT facilities more frequently in their workplace for those schools installed ceiling-mounted digital projectors in general classrooms [7, 8]. The second-phase of the study confirmed this case and there was a further development of the trend. Although the cost of setting up a ceiling-mounted LCD projector was expensive, which costed around US$4000 per projector and set up, it was commented as worth for promoting the use of IT in learning and teaching. Teachers showed willingness to use the IT facilities in general classrooms when it was so convenient and easy to carry out their work by using these facilities in classrooms. Table 4 tabulates the findings of the current study on the planning, acquiring and existing distribution of LCD projectors of pilot schools.

Table 4: Planning, acquiring and existing distribution of LCD projectors of pilot schools

Distribution of LCD Projectors	School 1	School 2	School 3	School 4	School 5	School 6	School 7	School 8	School 9	School 10
a. Existing Projector per School Hall	0	1	1	1	1	1	N.A.	1	1	1
b. Existing Projector per Computer Classroom	1	1	1	1	1	1	1	1	1	1
c. Existing Projector per General Classroom	0.25	0.23	0.25	0.25	0.25	0.25	1	1	1	1
d. Existing TV Connector per General Classroom	1	0	0	0	0	1	0	0	0	0
e. Acquiring Projector per General Classroom					1	1				
f. Planning Projector per General Classroom		1	1							

Results of the study showed that eighty percent of the pilot schools installed LCD projectors in their school halls for large group sharing and presentation. All computer classrooms of the pilot schools possessed ceiling-mounted LCD projectors for instruction and class presentation. Forty percent of the pilot schools set up ceiling-mounted LCD projector in all general classrooms. The ratio of existing projector per general classroom was 1. The other six schools had such ratio ranged from 0.23 to 0.25. Two schools resolved the problem on classroom projection by using TV. However, one of the schools told the research team that ceiling-mounted projector would soon replace TV display because projector could provide better quality

display and the school had acquired sufficient funding for the replacement. For the other four schools, one of them acquired funding for updating the projector per classroom ratio to 1; two of them were planning for the updating but there was no funding at that moment; and another one of them was designing a rotational plan of the school timetable so that all classes could use the ceiling-mounted LCD projection for a certain day of the week. In other words, nearly all schools recognize that ceiling-mounted LCD projection was a necessary tool for presentation in classroom. This finding indicated that integrating IT into learning and teaching needed the support of the IT facilities and those issues such as their readiness, convenient to use and reliability must be addressed.

4.3 Integration of IT in Curriculum

All pilot schools attempted to integrate IT in school curriculum. Data collected from the first phase of the study indicated that there were three ways of curriculum integration. They were (1) interactive delivery of multimedia-teaching unit, (2) presentation of digital knowledge object, and (3) active learning. Interactive delivery of multimedia-teaching unit refers to the use of interactivity and multimedia capability of the computer to deliver units of curriculum contents. Teachers themselves develop most of the teaching units. The main aim of this type of integration is to improve the efficiency of teaching. Presentation of digital knowledge object means teachers present knowledge objects such as pictures, animations, or videos related to the curriculum to students. The main objective of this type of integration is to offer authentic stimuli facilitating class discussion. The third type of integration is to organize learners to learn actively when they are empowered with IT.

All teachers and school principals in the pilot schools showed a strong sense of developing multimedia-teaching unit for improving the traditional classroom learning and teaching activities. The general phenomenon is that there was a great demand on the multimedia-teaching units but the supply was scarce. This was the results of the study of the first phase. Data collected from interviews, site visits of classroom, browsing school websites and Intranets, teaching plans and sample work of students from the second phase of the study indicated that the three ways of curriculum integration were still dominant but the proportion of the three types of integration had changed and the ways to advocate active learning were extended. Active learning included not only project-based work but also learning-on-demand. Table 5 summarizes the three types of integration of IT in curriculum. Pilot schools practising project-based work is denoted by a letter "a" and learning-on-demand by a letter "b" in table 5.

Table 5: Types of Integration of IT in Curriculum

Types of Integration	School 1	School 2	School 3	School 4	School 5	School 6	School 7	School 8	School 9	School 10
Multimedia-Teaching Unit	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Digital Knowledge Object				✓	✓	✓	✓	✓	✓	✓
Active Learning				b	b	B	a, b	a, b	a, b	a, b

Results of the current study clearly indicated that developing multimedia-teaching units for improving traditional classroom teaching was still the dominant type of integration. However, there were some further developments. One of the pilot schools stated that they had developed all multimedia-teaching units for the traditional curriculum. This school planned to deliver one-third of the teaching units on its Intranet for students' self-directed learning. The other nine schools required teachers to participate the development by producing some teaching units. Most schools required teachers to develop two multimedia-teaching units in an academic year. One school started to assist teachers to develop web-based learning contents with feedback instead of developing multimedia-teaching units. Another school revised its plan of developing teaching unit by requesting teacher to design storyboard and provide digital knowledge objects. The implementation work would be handed over for commercial software vendors.

The percentage of pilot schools, using the computing and networking capabilities for presentation of digital knowledge objects, increased from twenty to seventy. There were at least two reasons. Firstly, digital knowledge objects could be collected relatively more easily than developing multimedia-teaching units. Presenting digital knowledge object may enhance the effectiveness of teaching. Interview results reflected that knowledge objects were particularly applicable to subjects like General Studies, Art, Music, Physical Education and Civil Education. Digital knowledge objects such as pictures, music and videos allow students to learn by simulation, and learn how to appreciate. They help students to act with sympathy, and may stimulate discussion and critical thinking.

The third type of integration increases even more. The ratio of pilot schools, adopting this type of integration, increased from less than ten percent to seventy percent. These schools encouraged and organized learners to learn actively with IT. There are two types of activities that advocate learners to learn actively. They were (a) project-based work, and (b) learning-on-demand. One of the prominent learner-centred activities was to organize learners to do project-based work. Learners empowered by IT could use tools such as the search engines and presentation software to collect data and present information. This type of integration may facilitate collaborative learning and can polish lifelong learning skills.

Schools found that a content-rich Intranet can encourage learning-on-demand learning. Teachers discovered that learners liked to revise those multimedia-teaching units used by teachers. Two schools provided digitised Educational TV programme on video server or VCD for students' free access. Students could access these learning resources on demand. During the school visits, it was observed that students began to access schools' Intranet to retrieve learning resources and teacher' s multimedia teaching units. A variation of learning-on-demand type of activity is learning-on-demand with feedback. Learning-on-demand with feedback attracted learners to learn actively by providing immediate feedback. Two of the pilot schools installed virtual CD towers in their Intranets. Learners could access educational CD-ROMs by connecting to the school Intranets. These CD-ROM learning materials were attractive to students because feedbacks were usually provided and learning pace could be adjusted. Another pilot school developed web-based learning materials with feedback. It was speculated that feedbacks could motivate students to learn.

4.4 Staff Development

Results from the study of pilot schools in the first phase indicated that most schools were organising school-based training for developing teachers' competencies in using technology for learning and teaching. School-based staff development solved some problems like tailor-made training for teachers of the teaching environment. However, school-based staff development also limited the perspective of teachers on the potential of technology to improve only the traditional paradigm of learning and teaching. This argument is supported by the fact that all pilot schools regarded developing multimedia-teaching unit as a prominent part of integrating IT in school curriculum. It was observed that this was still the dominant approach in the second year of the IT pilot scheme. It could be inferred that most schools were adopting the gift-wrapped approach in promoting IT in education by adding technology to traditional educational practice [16]. However, the gift-wrapped approach will limit the development of skills and processes of learner that support learning as a lifetime habit. Therefore it is critical to conduct staff development by developing teachers' sense of harnessing technology for rethinking and redesigning educational practice.

Staff development is the key for cultivating culture of learning and teaching. Therefore, teacher' s development on IT competency should not just focus on developing teachers' IT ability but should also provide space to encourage teachers to redesign educational practices for creative and lifelong learning [17]. It is speculated that organizing staff development by visiting schools with best practices on redesigning educational practice could facilitate cultural shift. This kind of activity may excel the emerging paradigm of learning and teaching in the information era.

4.5 School Policy

All schools attempted to articulate policies to address issues derived from implementing IT in education. The following are the observed common policies of the pilot schools on integrating IT in the school curriculum. Firstly, organizing CAP for students. Secondly, requiring all teachers to contribute in the development of multimedia-teaching units. Thirdly, advocating teachers to share the developed teaching-units within the school. Fourthly, providing computing and networking capabilities in classroom for learning and teaching.

The following are individual policies on integrating IT in the school curriculum advocated by some pilot schools:

- Optimizing students' opportunities for accessing the computing and networking capabilities of the school.
- Organizing the computer awareness curriculum to synchronize with application for learning subject curriculum.
- Reinterpreting and reorganizing the traditional school curriculum to cope with the changes introduced by IT.
- Optimizing students' opportunities to access curriculum learning resources.
- Encouraging teachers to visit schools demonstrating best practices on IT in education.
- Encouraging students empowered by IT to do project-based work.

It can be speculated from the last three common policies that all pilot schools are working for improving the traditional learning and teaching practices using the computing and networking capabilities. However, the individual school policies on integrating IT in curriculum reflect that some pilot schools are attempting to establish a favorable environment to welcome the emerging paradigm of learning and teaching. Principals should work with teachers to think and design school policies for such a pursuit.

5 Discussions and Implications

The core research question of the study is to investigate the changes introduced by the using of IT in learning and teaching. This section will discuss the two subsidiary research questions from the result of the study. Firstly, **what are the observed roles of IT in improving the traditional mode of curriculum instruction?** Secondly, **what are the critical factors identified from the study that will enhance learning for the emerging paradigm of creative and lifelong learning when learners are empowered by IT?**

5.1 Improving Traditional Curriculum Instruction

Exploring ways to improve classroom teaching is the main concern of principals and teachers in the pilot scheme. Joyce and Calhoun [18] studied the effectiveness of teaching mode on students' learning for more than forty years. Results of their studies indicated that learning should include both the memorization of factual knowledge and knowledge construction. There is the basic knowledge of the core school curriculum, such as the fundamental knowledge for learning language and mathematics, which need effective transmission. There are also parts of the curriculum that involve conceptual understanding, communication skill, problem solving ability and creativity. Teachers should assist students to learn them by knowledge construction and assist learners to learn how to learn such ability. Traditional curriculum instruction put efforts to knowledge transmission. The emerging paradigm draws focus to knowledge construction.

Results of the study indicated that the use of IT could improve traditional curriculum instruction in two ways. They are **interactive delivery of multimedia-teaching unit** and **presentation of digital knowledge object**. Teachers of the pilot schools reflect that interactive delivery of teaching contents and presentation of digital knowledge object can shorten teaching time and may enhance teaching quality. There are three main reasons. Firstly, context of teaching and scenes of discussion can be displayed in one shoot. Teachers can ask contextual questions or stimulate students to think immediately with the help of the authentic presentations. Time can be saved from wordy description of scenarios or spending time on sticking diagrams on boards. Secondly, adopting multimedia technology and interactivity of computing capability can assist the teaching of abstract concepts. Interactive teaching contents can be easily replayed for consolidation of concept to be learnt. Therefore the efficiency and effectiveness of learning and teaching may be attained with the help of multimedia-teaching units. Thirdly, there are many drill and practice exercises in the traditional paradigm of learning and teaching. Teachers spend quite a lot of time on validating answers with students. With the help of the TV sets or LCD projectors, teachers can display answers and check them with students efficiently. Time for writing answers on board or reading answers aloud can be saved. Time saved from efficient teaching maybe used for exploring possibilities of learner-centred learning.

5.2 Possibilities of Creative and Lifelong Learning

In responding to the need of every individual to become a lifelong learner, one of the main objectives of the school IT pilot scheme is to develop students with lifelong learning abilities. "Lifelong learning is a continuous engagement in acquiring and applying knowledge and skills in the context of self-directed problems" [16, p.12]. Therefore, learners in the information era are required to work independently, to possess skills and abilities to learn, to communicate and work collaboratively with workmates, and to work with self-initiatives.

Results of the study indicates that those pilot schools which advocate active learning such as group project work and learning-on-demand will favor learners to meet the need of the future society. IT facilities themselves cannot enhance learning and teaching for the emerging paradigmof creative and lifelong learning. It depends on how the learner makes use of the IT facilities to either learn independently or work collaboratively with their workmates. Establishing school policies, such as optimizing students' opportunities for accessing the computing and networking capabilities, organizing a coherence computer awareness curriculum to support subject curricular learning, and reducing curriculum content of the traditional formal

curriculum to cater self-directed work, will increase the possibilities to support learners to learn like a lifelong learner. For example, using those expensive classroom LCD projectors as content delivery tool or group project presentation and communication tool will be one of the reliable indicator to illustrate the possibilities of creative and lifelong learning of our learners.

Therefore, pilot schools desire to contribute in the information era should provide not only **a convenient and reliable IT infrastructure** for learners and teachers, but should also develop **a content-rich Intranet** and devise **appropriate school policy** to support and promote lifelong learning. Whether IT facilities can enhance the paradigm of learning and teaching depends on how learners make use of the facilities to learn independently or work collaboratively in projects with their workmates. Devising school policy to promote the emerging paradigm will be a crucial role of principals and teachers. School policy should be formulated from **strategies developed by principals and teachers**, who rethink and redesign educational practice for lifelong learning support.

6 Conclusion

Five main items of the TMM model were selected for detail study in this research. They were the student use, teacher use, curriculum integration, staff development, and school policy. They formulated the framework of the study. The initial research results of the study show that some pilot schools are **optimizing students' opportunities** for accessing the computing and networking capabilities of the school environment. It is also speculated that acquiring a **LCD projector in each general classroom** is an important part of the IT infrastructure for promoting the use of IT in schools. The convenient use principle for acquiring IT infrastructure was proposed in the first phase of the study and was re-confirmed by the current study. All schools are motivating teachers to use IT in order to improve the effectiveness of the traditional mode of learning and teaching. All schools are **developing multimedia-teaching units** as one way of integrating IT with the existing school curriculum. Seventy percent of the schools integrate IT with the curriculum by selecting digital knowledge objects for presentation. Some schools are struggling for offering opportunities to students for active learning. It is critical to conduct staff development by developing teachers' sense of **harnessing technology for rethinking and redesigning educational practice**. Four **common school policies** of using IT to improve the traditional paradigm of learning and teaching are identified. They are organizing CAP; developing multimedia-teaching unit; sharing the developed teaching-units; and providing computing and networking capabilities in classroom. A number of individual school policies are identified from some of the pilot schools for promoting active learning.

Results of the study show that **IT plays two roles to improve the traditional mode of learning and teaching**. They are the interactive delivery of multimedia-teaching unit and the presentation of digital knowledge object. Time saved from efficient teaching may be used for exploring possibilities of learner-centred learning. **Four factors were identified from the study as critical to enhance learning for the emerging paradigm of creative and lifelong learning**. They are a convenient IT infrastructure, a content-rich Intranet, appropriate school policy and strategies for lifelong learning support. School policy should be formulated from rethinking and redesigning current educational practice for lifelong learning support. This study is still in progress. Further result of the research will be reported after collecting more detail data from the pilot schools.

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Health risks with Computer Use in New Zealand Schools

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With the increased use of computers, and particularly with the increasing use of the Internet in schools, health and education professionals have suggested the need for teachers and students to be ergonomically conscious when using computers. A project was conducted in 1999 to investigate the extent of awareness of health risks associated with computer use in schools of principals, teachers, and administrators of all the primary and secondary schools in Otago and Southland, New Zealand. Results in this study show that although a high proportion of the respondents were aware of these issues, few people took any active preventive measures or participated in any professional development to reduce these health risks. It is also found that nearly two-third of the school administrators, more than half of the teachers, and nearly 30% of the principals in this study had experienced some kind of health problems related to computer use. Strategies to deal with these issues such as the need for professional development are also discussed in this paper.

Keywords: **Health Risks, Social Implications**

1 Introduction

With the increased use of computers, and particularly since the advent of the Internet in schools in recent years [1], health and education professionals have suggested the need for teachers and students to be ergonomically conscious when using computers [2,3,4,5]. They are concerned about a number of health risks involved with computer use which range from discomfort such as eyestrain, wrist and shoulder pain, and overuse syndrome, to musculoskeletal injuries [6,7]. According to some reports (eg refer [7]), the most widespread health risk of computer use is eyestrain. One common problem experienced by frequent computer users is visual fatigue and eyestrain leading to sore and burning eyes, headaches, double vision, and even to nausea [8]. Computer users need to understand that reading text from a computer screen is significantly different from reading print-based materials. Unlike print-based materials which reflect light, the computer monitor (the visual display unit, VDU) is a self-illuminated object. Looking directly at the computer screen is somewhat like looking into a light source. Less surrounding light may be needed or the VDU may create discomfort to the eyes [9]. Poorly designed work environments may thus accentuate the development of Computer Vision Syndrome, defined by the American Optometric Association as "the complex of eye and vision problems related to near work which are experienced during or related to computer use" [10]. This is poised as a big problem for children.

Maintaining a good posture is another example of importance if the computer is to be used for an extended period of time. Poor body posture, as well as poor design of the workstation, may lead to muscle pain, particularly in the shoulders, neck, lower arms and wrists, which, if not attended to, may develop into what are commonly called Repetitive Strain Injuries (RSI). No doubt ergonomically designed furniture and workstation could mitigate some of the 'at risk' postures when teachers and students using computers [6,11]. As teachers and students increasingly have to use the computer for instructional and administrative purposes, they need to understand these issues and to form good work habits as early as possible since bad habits, once formed, are usually difficult to unlearn later.

There is a need for teachers and school administrators to be more ergonomically conscious. The use of laptop computers in schools, for example, where students are expected to use a small keyboard, trackball, or some pointing device for extended periods of time, has already posed a greater risk of developing

occupational overuse syndrome (OOS) [12]. A recent study surveying 314 children in three Australian schools shows that 60% of the participants suffered some kind of back, neck, head and shoulder pain when using and carrying laptop computers [13]. At present very little research has been conducted on health and safety issues associated with computer use in schools, although ergonomic research in the workplace in other settings has been undertaken by organizations such as the International Labour Office [14]. In New Zealand, no systematic research on these issues has been conducted in schools. To fill this gap, a research project was undertaken in 1999 surveying the awareness of principals, teachers, and administrators of all Otago and Southland schools in New Zealand on ergonomic issues and health risks with computer use. Data collected in this study was used for designing training programmes as well as for policy recommendation and formulation.

2 Research questions

The following research questions were investigated in this study:

1. To what extent were Otago and Southland school principals, teachers, and administrators aware of and understood the potential health risks associated with computer use?

2. To what extent have Otago and Southland school principals, teachers, and administrators experienced health problems associated with computer use?

3. To what extent did primary and secondary schools in the Otago and Southland regions have a health and safety policy with regard to computer use by staff, teachers, as well as students?

4. What were the strategies and practices adopted by schools to deal with health issues with computer use?

2.1 Participants

As a regional study, three sets of questionnaires were administered to the (a) principals; (b) school administrators (secretaries); and (c) computing teachers/computer coordinators of all the schools in the Otago and Southland regions of New Zealand. A total of 852 questionnaires were posted to 284 schools (246 primary and 38 secondary schools). 362 questionnaires (43%) from 207 schools (73%) were returned. The overall response rates for principals, teachers, and administrators were 56%, 30%, and 41%, respectively. As can be seen from Table 1, the response rates for primary school principals and secondary school teachers were particularly high.

	Primary Schools		Secondary Schools		Overall Responses	
	Number	%	Number	%	Number	%
Principals	145	59	14	37	159	56
Teachers	59	24	27	71	86	30
Administrators	102	41	15	39	117	41

Table 1: Response rates of principals, teachers, and administrators

3 Awareness of health risks with computer use

3.1 Time spent using computers

Principals, teachers, and administrators in this study were asked the length of time they spent using computers at school. Table 2 shows that school administrators (secretaries, managers), particularly of those in secondary schools, spent much more time (5.1 hours on average per day) on the computer than principals and teachers. Secondary school teachers also spent twice the amount of time on the computer than their primary school counterparts (see Table 2).

	Primary Schools	Secondary Schools
Principals	1.5	1.6
Teachers	1.1	1.9
Administrators	2.9	5.1

Table 2: Average hours spent on the computer per day by principals, teachers, and administrators

3.2 How often did they have breaks?

It is important to have frequent short breaks if users spend an extended period of time on the computer. In this study when asked how often they took breaks when working on their computer, only 5% of the respondents reported having breaks regularly and 1.4% of the respondents reported they rarely had breaks. It is interesting to note that nearly one-quarter (24%) of the respondents could not provide a specific answer to this question and 20% of the respondents did not provide any answer at all. It seems that quite a large proportion of the respondents (44%) have not yet formed a habit of having regular breaks when using computers, as reflected in the following comments:

"Whenever I feel I need to..."
"When finished an item & before starting another"
"usually work until task is completed"

For some teachers, taking breaks was never a big issue because they were "frequently interrupted" anyway. But others seldom took breaks:

"...When working for extended periods (30 mins +) I very rarely take breaks."
"...may have break after working more than 2 hrs."

About half of the respondents have provided a more specific answer to this question. Within this group, principals took breaks most often (on average every 37 minutes), followed by teachers (on average every 43 minutes). However, administrators who indicated they spent far more time on the computer, took breaks least often (on average every 46 minutes).

3.3 Were respondents aware of the health issues related to computer use?

In the questionnaires the respondents were asked whether they were aware of the following health risks associated with computer use: (a) back pain; (b) lower arm pain; (c) neck pain; (d) shoulder pain; (e) wrist pain; (f) headaches; and (g) eyestrain. Overall, between 69% and 91% of the respondents were aware of a number of these health risks, as can be seen from Table 3.

	Administrators	Teachers	Principals
Back Pain	92	85	86
Lower Arm Pain	86	79	71
Neck Pain	91	85	79
Shoulder Pain	85	69	71
Wrist Pain	91	92	82
Headaches	91	83	81
Eyestrain	91	90	90

Table 3: Percentages of school principals, teachers, and administrators who were aware of health risks associated with computer use

High level of awareness, however, did not result in high level of active preventive measures undertaken to reduce these health risks. For example, when principals and teachers were asked specifically whether they paid any attention to their own postures, as well as to the lighting in their work environment, only 54% of the teachers reported that they did watch their posture and 60% of them paid attention to the lighting of their rooms. As for principals, they paid even less attention to their postures (49%) and lighting (57%).

The majority of the respondents did not have any purpose-built furniture either. Table 4 shows that although 95% of the administrators surveyed in this study had an adjustable chair to use, less than half of them (42%)

had an accompanying adjustable computer desk. Very few of the teachers and principals had other ergonomically designed furniture to use. The school administrators were also asked whether they have requested any specific items which would make their use of the computer safer. 49% of the administrators in primary schools and only 33% in secondary schools have requested such items.

	Administrators	Teachers	Principals
Adjustable Computer Desk	42	8	22
Adjustable Chair	95	35	75
Foot Support	24	4	3
Screen Filter	41	2	13
Paper Holder	54	27	23

Table 4: Percentages of respondents having purpose-built furniture

The situation was far worse for students. As can be seen from Table 5, very few students used ergonomically designed furniture at school, particularly primary students (although they only spent on average approximately an hour per week on the computer). The situation for secondary students was a little better, but they spent a lot more time on the computer than their primary counterparts (on average 3.7 hours per week).

	Primary	Secondary
Adjustable Computer Desk	5	5
Adjustable Chair	7	70
Foot Support	2	10
Screen Filter	4	15
Paper Holder	13	57

Table 5: Percentages of students using purpose-built furniture

3.4 Health problems with the respondents

When asked whether they had experienced any health problems related to computer use, overall nearly half (47%) of the respondents had experienced some kind of problems themselves. School administrators were affected most (61%) and this was more significant in secondary schools (73%) than in primary schools (57%).

As school administrators worked much longer hours on the computer than the other two groups, it is not surprising that they reported having more health problems. Of the 117 administrators who have returned their questionnaires, seventy-one (61%) reported they had experienced some kind of health problems associated with computer use. Five of these respondents have already had RSI. Thirty-three (28%) administrators had experienced eyestrain, and nine of them reported a deterioration of their eyesight, and as a result had to wear prescription eye glasses. Other health problems included hand and wrist pain (37%), neck pain (30%), shoulder and lower arm pain (41%), and back pain (13%). A third major problem was headaches (27%). The following comments show the importance of having an ergonomically designed work environment:

> "I have OOS in hands, wrists, arms, shoulder tension and neck tension leading to headaches. This was originally due to poor equipment. I now have the proper desk etc and have to monitor how much I use the computer."
> "Chronic neck pain prior to purchase of a copy holder. Eye sight deteriorating - glare is a problem."

As for teachers, forty-five (52%) of the respondents reported having health problems related to the use of computers at work. The two most widespread problems were wrist pain (49%) and eyestrain (44%). The following are some of the teachers' comments:

> "Wrist...when doing a lot of mousing & editing a school magazine – kept me awake at nights. Also lifted some chairs & a computer monitor during room refurbishment. Lifted badly & was off work two and a half weeks with pinched nerve. Could not sit at computer for 4-5 weeks." (A male high school HOD, Computing)

"Back – too tense when working against clock. Arm & wrists – pain after stretches at keyboard. Headaches – at end of every working day. Eye strain – tired, burning eyes." (A female high school HOD, Information Technology)

Forty-five (28%) principals reported having experienced similar health problems related to computer use as teachers, with wrist pain (45%), eyestrain (33%), and neck pain (31%) being the most common ones.

"Eye – using old b/w screen – very sore. Health nurse advised me to minimise my use of that particular computer. Shoulder/neck pain – more evident when programme fails to function properly at a crucial time." (A male primary school principal)

3.5 Dealing with health risks

3.5.1 The lack of information

Having information about ergonomic issues is the first step towards minimizing health risks. In this study the respondents were asked if they had knowledge of ergonomically designed equipment or furniture. They were also asked to give one or two examples as well. Table 6 shows that apparently the respondents' level of knowledge of ergonomic products was very high. Overall, staff in secondary schools knew more about ergonomic furniture and equipment than their counterparts in primary schools.

	Primary Schools	Secondary Schools
Principals	84	93
Teachers	76	96
Administrators	72	93

Table 6: Percentages of respondents who had knowledge of ergonomic products

However, when asked whether they knew any computer software which would help them reduce the health risks of computer use the percentages were much lower, as can be seen from Table 7.

	Primary Schools	Secondary Schools
Principals	11	14
Teachers	9	26
Administrators	6	7

Table 7: Percentages of respondents who had knowledge of software programmes

The principals were asked whether they were aware that the government had developed some guidelines related to health and safety issues in school computer use. Although a package which includes guidelines on safety issues in ICT use was sent out by the Ministry of Education in 1998 to all schools, only 17% of the primary schools and 14% of the secondary school principals were aware of these guidelines.

When asked what specific information they needed, some suggested:

"Information re harmful properties in the air from this electronic gear. How close to sit to monitor screen to avoid exposure."
"Furniture/equipment at the Primary end of education – what's a good height for screen? Are chairs available for 'wee ones'?"

Some requested very detailed information:

"How much time I should sit at the computer before having a break, what exercises I should do and what other equipment would help to counteract some of the problems..."

The respondents were also interested in legal issues related to the health risks of computer use. As suggested by Cameron (cited in Bell, 1999), the public liability health insurance risks have not yet been clearly calculated and could be a major concern for school management in the near future. The following is some of the legal information requested by the respondents:

"Legal advice on possibility of students claiming against schools in later life."
"What are the legal requirement of our employer to provide for this. Strategies for combating to [sic] problem"

3.5.2 The lack of policy guidance

Surprisingly, not a single secondary school in this study had a policy on health and safety issues associated with computer use. While primary schools fared better, only about 6% of them had a standing policy. However, 85% of the primary and 86% of the secondary school principals felt the need for some kind of policy and guidelines. A number of them preferred that policies be developed by the Ministry of Education as 'it would be easier for one organization to carry this out rather than every school or institution reinventing the wheel by producing their own". Some principals felt that since "computer use is being imposed upon schools" and the "new curriculum initiatives require that schools be equipped with computers", the Ministry of Education therefore should be responsible for developing and disseminating guidelines for computer use in schools. These guidelines should be:

"Concise, clear suggestions that are practical for implementation in schools/classrooms..." (A primary school principal)
"...Ministry driven not left up to individuals to decide and Ministry funded workshops easily available especially to rural people." (A rural school principal)

Principals preferred practical and systematic information, provided by experts, and enforced by an outside body such as the Ministry of Education.

From the comments of the principals it is clear that they have a huge concern about how ergonomically designed equipment and furniture should be funded as "the Ministry of Education [is] very good at generating guidelines but very reluctant to resource them". According to one principal, the Ministry of Education should:

"provide the funding and staffing for proper management of computer systems, computer training...education and...development rather than stating 'funding is available in the operations grant." (A secondary school principal)

From another principal,

"so that there is a set of national standards, information and guidelines for schools to make use of. This resource would have to be accompanied by efficient funding to enable aspects to be put into practice." (A primary school principal)

3.5.3 The lack of professional development

Only 10% of the primary and 21% of the secondary schools in this study had organized professional development related to health issues with computer use for their staff. When organized, they were considered as part of the overall professional development, "included in...training for staff on computer skills" and they usually involved some form of inspection from the Occupational Safety and Health Authority (OSH):

"Administrative secretaries have been given reading material regarding the health and safety issues. OSH visits make us aware and keep us up to speed regarding 'good employer' aspects of ensuring staff are aware of H & S [Health and Safety] issues within the responsibilities and rates of their positions".
"Visit to inspect computer facilities by OSH expert...report and recommendations to Board [of Trustees] by OSH expert...address to staff by OSH expert ...replacement/purchase of computer equipment to reflect above recommendations..."

Professional development for the respondents meant gaining knowledge of ergonomic products or measures to prevent OOS. Topics such as psychological stress related to computer use, as well as the feeling of incompetence when using computers with their students due to inadequate training and professional development were seldom included.

Some principals did not know what to include if a professional development programme was to be organized:

> "I would need to seek expert advice on this."
> "I have no idea..."

Some principals even doubted the need for professional development in this area:

> "Our teachers are not using computers during school hours but children are."
> "Very few school personnel use computers for extensive periods so I'm not sure how great the need is."
> "Not interested at this time...It is not a concern to me. I know of problems. But until it affects me I sail on without concern."

It is clear that health and safety issues were not emphasised in professional development in most schools. The following comment summarized well the feelings of many principals,

> "Time has to be spent on training for teaching and computer use. Health and safety is important but not the driving force for in-service training".

The lack of professional development in this area may explain why health issues associated with computer use were seldom discussed with students. In the survey, it is reported that only 34% of the primary teachers and 59% of the secondary teachers have discussed these issues with their students. This is rather unfortunate as, increasingly, students will spend more time using computers in school as well as at home. In this present study 12% of the primary and 11% of the secondary schools have already indicated that their students were using laptop or notebook computer at school. Students need to be aware of these health risks and preventive measures need to be instigated urgently if a safe work environment is to be provided for them.

4 Concluding remarks

Although computer use in the classroom or in the school office is usually very different from an office setting where people can spend all day working on a computer, this study documents a rather widespread health problem in the school setting, particularly with school administrators. This study documents the lack of depth in the understanding of these health risks as well as the inability to come up with some strategies to deal with them, which was at least partly due to the lack of efficient dissemination of information and national guidelines from the Ministry of Education to individual teachers. It was also due to the lack of professional development and discussion of these issues in schools. From the study, we come up with the following recommendations:

1. The need to consider the health risks as a matter of priority. It should be noted that parents and educators are not wilfully ignoring the health risks of having poorly designed computing furniture or the importance of professional development. What they are more preoccupied with is the educational opportunities of the burgeoning technology, and the computer hardware and software needed to meet the educational needs. As commented by a couple of respondents,

> "The issues of health & safety were discussed as our school invested in computer technology. However, the cost of complying with health & safety issues in an old school building was expensive. The priority is to provide hardware at this stage. Our 'typing room' has adjustable chairs, but 'computer room' & IT room have 'ordinary' chairs & desks."
> "How does the school get the money to buy chairs/desks needed when the IT gear is demanding every dollar of hard-won fundraising?"

Ergonomically designed furniture is not a priority compared to hardware and software purchase as 'by the time a school purchases hardware and software [it] seems little [is] left over in [the] budget for ergonomic furniture". Schools simply cannot afford to provide the money. It is a national issue, rather than a local issue. As for professional development, the focus is on how to use the computer to teach and "as part of ICT inservice...these issues are easily overlooked while dealing with the actual understanding of programmes, technical knowledge, etc." It is now high time to treat this as a priority.

2. The need for resourcing. This brings us to our second point: the need for adequate funding to resource ergonomically designed equipment as well as professional development for teachers and school administrators. As commented by one primary school teacher in this study,

> "Computers & chairs at my school are extremely old, damaged beyond repair. Poor choices been made & no funding available to rectify situation. I am unable to work in such conditions & will bring in own personal equipment as not prepared to work with 'dangerous' equipment."

There was a general feeling that funding should come from the national level:

> "This a large issue for education as all available funds targeted into computers & software. Problems of seating at computers & general furniture that has been provided for children an issue that needs lot more attention at national level as unless funds were provided the cost would be out of most schools ability to provide."
> "Teachers within TIM [Text and Information Management] & computer curriculum fully aware of potential health risks associated with computers. Until money is forthcoming for implementation of ergonomically designed computer rooms then professional development is simply **just more talk**. If, in this age of technology where supposedly all schools will march down the urge/rush to have schools & students embrace the wonders computers, where is the finance to ensure health & safety of these same students? You **cannot** have one without the other, but schools do because there is no requirement to do otherwise."

3. The need to consider the school-home link. The school-home link cannot be ignored when discussing issues related to health risks with computer use, as home and after hours use is the most likely time for health issues to arise. A principal from an Intermediate school commented:

> "As a lead school in ICT it is an area we should consider. In most cases staff and pupils sit for only a short period of time at the computers but even so it is important that health and safety issues are addressed. I suspect that this should also be stressed in the home as often children and adults spend long periods of time in front of their computer."

As it is increasingly common for students to have computers at home and typically students spend a lot more time playing computer games and chatting on the Web than using computers at school, it is important to promote healthy computer work habits not only at school but at home as well. Unfortunately, many parents are more concerned about how fast their kids can search the Internet than forming good work habits.

4. The need to take up a broader perspective. In this study we have only looked at the physical health risks associated with computer use. However, the lack of professional development in ICT has created huge psychological stress for many teachers. As commented by one respondent:

> "A great anxiety whenever I have to use it as my inadequacies are likely to be exposed..."

The inadequacies referred to by this respondent had to do both with the lack of training on computer use as well as how it is to be used as a teaching and learning tool. Heath risks teachers should be aware of ought also to include the anxiety and psychological stress they have to deal with in using computers in their classrooms.

In the final analysis, the computer users themselves have to take responsibility of looking after their own well-being. Providing teachers and students with ergonomically designed furniture as well as professional development will certainly help. However, I suspect it is only when they have an in-depth understanding of the issues and an ergonomically conscious work culture, created, and supported by the school as well as the wider community both locally and at the national level, that health risks associated with computer use in schools could be greatly reduced.

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Additional Information

A website has been developed as a result of this research project. Its URL is http://education.otago.ac.nz//NZLNet/safety/health_and_safety.html. This website is developed specifically for teachers and it consists of some very useful resources and links on health and safety issues associated with computer use.

Information technology competency for Hong Kong teachers - A new era and a new paradigm

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This paper reports a study on Hong Kong teachers' competency in information technology (IT). The Hong Kong Special Administrative Region (HKSAR) Education Department commissioned and funded this study. The study aimed to refine the four levels of IT competency for teachers as suggested by the HKSAR government in 1998, to recommend the appropriate professional development courses both in terms of contents and related strategies, and the appropriate assessments for all Hong Kong teachers. Multiple research methods were used in this study which included documentary analysis, interviews with experts in Hong Kong and other countries, focus group meetings with local government specialists, principals and teachers, and case studies of some local schools. A framework of IT competency in education for teachers was proposed together with a set of key attributes of a teacher who is IT competent in education. As well, a systematic set of professional development courses were outlined by the research team with a strong focus on how IT could be used in education. This study also suggested a number of professional development strategies to the Hong Kong government including school-based professional development including the concept of hub-schools, and centrally approved professional development providers. Moreover, portfolio assessment was recommended as a suitable way to assess the IT competency for Hong Kong teachers.

Keywords: **Teacher training, information technology, competency, professional development**

1 Introduction

In his inaugural Policy Address, the Chief Executive of the Hong Kong Special Administrative Region (HKSAR) pledged to make Hong Kong "a leader, not a follower, in the information world of tomorrow". To realise this vision, our future generation must be empowered with the knowledge and applications of information technology (IT). To this end then, Hong Kong's teachers must be IT competent in education so that the power of IT can be harnessed for the learning of their students.

In November 1998, the HKSAR Education and Manpower Bureau (EMB) published a policy document entitled "Information Technology for Learning in a New Era: Five-Year Strategy 1998/99 to 2002/03"[5]. This document, among other things, stipulated four levels of IT competency for Hong Kong teachers and outlined a timeline for all Hong Kong teachers to attain the different levels of IT competency over a period up until September 2003. However, the document also indicated that there would be a need to delineate and elaborate on the details of these four levels of IT competency and related training strategies.
Subsequently in 1999, the Education Department of the HKSAR invited interested parties to bid for a research contract, part of which involved the elaboration of these four levels of IT competency, the

recommendation of the appropriate courses and strategies for the professional development of Hong Kong teachers in IT as well as the assessment methods involved. The research team at the Hong Kong Institute of Education won this bid and the project officially began in April 1999. The report was accepted by the government and was released in October 1999 [1].

2 Aims of the Project

This project aimed to refine and elaborate on the four levels of IT competency for teachers as suggested in the "Five-year strategy on IT in education" published by the HKSAR Education and Manpower Bureau in 1998; and to recommend the core and optional course elements and training strategies, appropriate assessment tools and certification mechanism for professional development for four levels of IT competency for teachers.

3 Methodology

Information technology competency is a complicated, topical and important concept. A number of issues were considered before formulating the methodology of the current study. First, IT competency implies some form of literacy with IT. Second, it is an evolving concept and changes with the development of IT that tends to be rather rapid. Third, in the context of this study, we have examined IT competency in relation to teacher enablement and empowerment, which embraces the concept of teachers using IT as learning and teaching tools. Fourth, while most developed economies have made good starts with the professional development which enables teachers to use IT, Hong Kong comes in relatively late which means that special considerations need be made.

The methodology of the present study was based on a comparative perspective, which took into account of the pedagogical practices and competency standards in other socio-economic contexts. In this context, the major approaches used in this study included documentary analysis, substantive reviews of the literature and interviews with a number of experts in five countries (Australia, Britain, France, Singapore and the United States), meetings with local experts (including government specialists, major school operators, school principals and teachers), and case studies of five Hong Kong schools. Based on the data collected and analysed, specific policy and operational recommendations were then made.

The overseas experts interviewed came from five countries: Australia, Britain, France, Singapore, and the United States. The experts were selected based on their professional involvement in setting the IT competency in their countries. There were a total of 12 overseas experts interviewed.

The local experts who attended the focus group meetings came from a variety of sources. Some of them were experienced educators from the tertiary institutions in Hong Kong, some were dedicated frontline teachers and principals. And still some others were representatives from major school operators and from the HKSAR Education Department. There were more than 70 local experts who were consulted. It should be borne in mind though many different, sometimes opposing views were expressed during the focus group meetings. The facilitators of each of the focus groups then tried to facilitate the formulation of some kind of consensus opinions towards the end of the meetings.

The data collected from the visits to the five schools provided valuable insights into the implementation of IT in the Hong Kong school context and allowed the research team to gauge where Hong Kong teachers were at as far as IT competency was concerned and how these schools were handling teachers' professional development in this area.

4 Results and Discussion

From our review of the literature, interviews with experts, discussions at focus group meetings and case studies of schools, it was quite clear that the focus of IT competency under consideration should be on IT competency in education or IT in education competency rather than just IT competency for the sake of using IT. There was a very strong consensus among both the local and overseas experts on this particular issue. This was a critical issue when defining and elaborating the four levels of IT competency in the present

project as one refers to teachers using IT in education rather than using IT for other purposes. Therefore, it is imperative that the focus be on IT competency in education or IT in education competency.

This focus was also reflected in the formulation of IT competency standards in other countries. For instance, in France, three levels of IT competency have been established. The first two of these levels focus on the use of IT only and the third focus on the use of IT in Education. In England and Wales, the IT competency has the educational agenda well woven into the IT competency expected of the teachers over there. In Singapore, the government does not even evaluate the IT technical skills of teachers, rather in their professional development model, teachers are expected to integrate IT into daily learning and teaching as well as curriculum development.

The local experts expressed similar views during the focus group meetings. The following are some of the typical comments:

IT competency must be practical and related to the subjects that the teachers teach.
IT competency should be skill-based initially but should relate to integrating IT into education.
IT competency should be functional based on teaching and learning tasks that teachers have to achieve.

These views are shared by almost all the authors who write about IT competency in education around the globe [e.g., 2, 4, 7, 9, 11, 12, 13]. However, the views expressed by these authors differ somewhat in how these skills relate and be learned by the teachers. For instance, some views tend to suggest that IT as productivity tools and skills can be separated from their integration into learning and teaching contexts [13] whilst others suggested there needs be integration right from day one when a teacher starts to learn to use IT for learning and teaching purposes [11].

The notion of a dichotomous view of IT skills as productivity tools versus their integration in learning and teaching may be difficult to sustain if one considers recent research in situated cognition and learning. In this realm of research, it has been clearly pointed out that learners learn best when what they have learned can be anchored within a context that the learners can put what they have learnt into practice [10]. In defining IT competency in education and in the design of appropriate professional development activities, it would appear advisable and necessary that teachers' learning of IT skills be embedded within the context of education. This point reinforces the views about IT and information literacy which have to be learnt within a professional context.

In the light of the considerations above, the research team proposed a conceptualisation of the four levels into a matrix consisting of the four levels and three domains. The following diagram illustrates such conception.

Levels	Domains		
Basic	IT as Productivity tools	General Integration of IT in Education	Subject-specific Integration of IT
Intermediate			
Upper Intermediate			
Advanced			

One major issue in the professional development of teachers in IT is that often too much emphasis has been placed on the development of technical IT skills without sufficient focus on the application of IT in education. The proposed model will encourage educators to place due emphasis on how IT should be used in education and in particular subject areas in conjunction with the development of the necessary IT skills. Such a conceptualisation will have impact on the actual professional development activities as it will be essential to consider including the elements from the three different domains in all professional development activities. In particular, development of the IT knowledge and skills must, ideally take place in the context of either the general integration of IT in education and/or subject-specific integration of IT.

It should be noted that this conceptual model does not suggest that professional development activities could or should be divided into three separate domains. On the contrary, this conceptual model emphasises that

professional development should be integrated. In other words, the development of using IT as productivity tools should be anchored within a general educational context and/or within subject-specific contexts. This view is very much shared by the overseas experts that we have interviewed. Indeed, in the professional development activities that the research team proposed to the Hong Kong government, all the three domains are closely interwoven together [see 1].

During the consultation with both local and overseas experts, there was very strong support for the three-domain classification. Some experts did suggest that the second and the third domains could be merged to become one. However, this was balanced by another set of views that teachers needed to understand cross-curricular and thematic applications of IT in education. Moreover, it was also surmised that teachers should not just focus narrowly on the application of IT in their own teaching areas. Rather, teachers need be aware of the potentials of integrating IT in other areas as well.

During the consultation process, it was also suggested that perhaps it might not be necessary to have four levels of IT competency, or at least, the four levels should be collapsed into two or three levels. The research team understood that that the four-level IT competency was set as Hong Kong government policy and could not be changed. Therefore, the four-level and three-domain matrix stands as it is.

Moreover, the professional development needs to include general issues such as the changing views of learning and teaching, the changing roles of learners and teachers, how to decide when to integrate IT into learning and teaching, and the strategies that teachers can use to engender such changes within our school system. The EMB document refers to the paradigm shift in learning. In order to effect such a change in Hong Kong classrooms, it is important that there be corresponding changes in Hong Kong teachers' views about learning and teaching.

In our search for similar efforts in defining IT competency by overseas government, overseas universities etc, it was very clear that IT competency was not just about the use of computers and its peripherals. Rather, it refers to a person's ability to handle information via the use of IT when appropriate. For example, in a study by Hoover [6] it was clearly stated that IT competency related to a person's ability to collect data, manage information, make decision, communicate and present. In the School Technology and Readiness Report [3], it was argued that IT Competency would include the necessary skills to acquire, organise, use, maintain, interpret, communicate as well as use technology to process information.

In the light of the above arguments, when formulating the key attributes of a teachers who is IT competent in education and the course contents of related activities, careful considerations were given to the issue of information literacy. For instance, in the courses designed, emphases have been placed on how the participants can process information through various forms of IT such as the accessing and searching of information on the Internet, the organisation and manipulation of information through software such as databases and spreadsheets.

It was acknowledged by all experts involved that IT competency needed to be modified with time. Given the rapid development of IT, it is almost imperative that IT competency will need be monitored and revised on a continual basis. For instance, Web browsers may be important in 1999 but may not be so in 2002. Similarly, the writing and design of Web pages may not be a skill expected at the Basic Level at present, but the situation may, and will probably change in 2001.

In the context of a need to modify IT competency on a continual basis, it is also very clear that the professional development should focus on generic skills with software. For example, for word-processing and presentation, rather than focusing on specific software such as Word and PowerPoint, the emphasis should be on the generic skills in operating word processing and presentation software. It is important that a distinction should be made between using particular software as an example in one category of software, and focusing on that software alone. By doing so, teachers can acquire the generic skills so that they will be better able to cope with new software and new versions of the same software. It also means that the shelf life of the IT competency can be prolonged.

In consulting with a large number of local and overseas experts and the literature on the professional development of teachers to use IT, it was clear that the issue of teacher empowerment needs be given very serious consideration when conceptualising IT competency, and, in particular, in designing the professional development programmes.

Given the amount of time allocated for each level of IT competency professional development, especially the Basic Level where only approximately 18 hours of course time is provided, it is important that a number of enablement strategies be used to facilitate the empowerment of teachers. These strategies include the emphasis on initial familiarisation and awareness, ongoing support after the initial courses including learning materials support and human support.

A lot of discussions during our consultation focused on the Basic Level which all Hong Kong teachers must attain in the next two years. There was clear consensus emerging from the focus group meetings and our consultation with the local and overseas experts that the IT competency at the first level should focus on confidence and basic skills building. It was suggested by all experts (local and overseas) consulted that the level of difficulty within the Basic Level should not be set too high so as to frighten the real beginners. The literature on the professional development of teachers also supports the notion that much of the initial stage of professional development requires confidence building and the development of some generic skills upon which the teachers can then develop further advanced skills themselves. The development of confidence and basic skills in using IT will form a good foundation for further self-learning of IT. The principle underpinning this development is the empowerment of teachers with IT.

However, given the little time budgeted for the professional development courses at the Basic Level and the commitment of funding for professional development at the Basic Level only at this stage (for the absolute beginners), it is important that beginners are aware of the potentials of other common applications in education. One needs to bear in mind that some 25% of teachers in Hong Kong will not be expected to go beyond the Basic Level of professional development. Therefore it will be to the advantage of the beginners that certain amount of course time at the Basic Level be devoted to awareness and familiarisation so that beginners can become aware of the potentials of some of the common application and instructional software that could be used in the classrooms. This professional development can include the demonstration and initial familiarisation of how software such as e-mail, presentation software, spreadsheet, databases and some common educational courseware can be used in education in general and in certain subject areas.

While it is recognised that there are many teachers in Hong Kong who might have attained the Basic level IT competency, the project team decided, after consultation with the experts that the IT competency at the Basic level be set at a minimum with no optional element. In other words, the elements proposed in the table below for the Basic level of IT competency would all be considered as core. The decision was based on the reasoning that those teachers who have attained the Basic Level IT Competency can further develop themselves at higher level of competencies.

While there were very interesting discussions for the Basic Level, there were not much controversies for the Intermediate, Upper Intermediate Levels and Advanced Levels. There were discussions on how some IT applications should be placed vis-à-vis a certain level but overall the discussions did not generate as much as debate as to the contents of the Basic Level.

When the research team attempted to define what IT competency is for Hong Kong teachers and delineate the scopes of the four levels of IT competency, we tried to look to our overseas counterparts for their experience. However, we found that we could not quite find a set of similar experience. In fact, very peculiar to the Hong Kong context, we have not found any country that has attempted to define four-level IT competency as we were trying to do. For example, in Britain, there was a holistic set of IT competency without dividing it into levels. In Singapore, the government did not even attempt to define a set of IT competency. In France, there are three levels but it was simply divided into some basic IT skills, general application software usage and linking IT with education. In Australia, the Australian Council of Computers in Education conceptualises IT competency in terms of categories: Understand the use of IT as a personal tool, understand the use of IT within the school as a workplace, institution site or learning place, use IT during the teaching and learning process.

We also consulted with our local experts who did not provide too much comment on the definition or the scope of the four levels of IT competency, suffice to say that the definition needed be flexible and should relate to the work of teachers in schools etc.

As we have indicated earlier, Hong Kong is relatively a late comer in integrating IT into its school system among the developed economies. Consequently, there were a number of issues that need be considered when we tried to define the scope of the four levels of IT competency.

First, from our consultation with the local experts, we were given a clear message that Hong Kong teachers were fairly adept in picking up technical and technological skills. These messages were given to us by frontline teachers and principals during our focus group meetings, and our meetings with the Teacher Preparation Working Party set up by the Government. Although the research team was not necessarily totally convinced of such assertions, it was nonetheless relieved to learn of such possibilities. While there was no attempt to "squeeze" in as much mastery of technical contents as possible at each level, this allowed the research team to be more confident to include more initial familiarisation at the lower levels.

Second, during our consultation with local experts, there were often suggestions that there was a dearth of software in Hong Kong that were suitable to the learning contexts of Hong Kong students, e.g. Cantonese–based, Hong Kong curriculum adapted etc. While there might be many ways to address this issue, training more Hong Kong teachers to produce software would clearly be one of them. There are many tools available to produce software at various levels of complexities. The research team has included some of them throughout all levels, e.g. presentation software, more sophisticated authoring tools and even more sophisticated programming languages at the Advanced Level. From experience elsewhere, it is clearly not reasonable to expect many teachers writing software, the proposed course structure will encourage more interested teachers to take up the challenge. It is also interesting to note that in two of our five case studies, one being a primary school and the other a secondary school, most teachers were involved in producing software for their own use initially.

In the end, we found that there were many common elements that should permeate all the four levels but different elements should be found at each of the four levels. We termed these common elements the Key Attributes of a Teacher who is IT Competent in Education. The Key Attributes can be conceptualised as consisting of three distinct but related areas. These areas are: The practice of teaching, facilitator of learning and general professionalism. The following is a description of the Key Attributes and the elaboration of the four levels.

Key attributes of a teacher who is Information Technology (IT) Competent in Education is a statement of excellence. It succinctly outlines the characteristics expected of an IT competent teacher in Hong Kong. Teacher preparation, continual professional development and self-learning are the major determinants of the extent to which these characteristics are evident in our teachers. It is assumed that not all the characteristics are to be found significantly in teachers who are at the lower levels of IT competency. Nevertheless, all are characteristics to which all teachers should aspire and continue to develop.

The practice of teaching

- Able to use IT as productivity tools to enhance the efficiency and effectiveness of a teacher's work.
- Able to use and integrate IT selectively and critically in learning and teaching contexts including addressing the individual needs of students.
- Be aware of the paradigm shift in learning and teaching including the changing roles of students and teachers, changing conceptions about learning and teaching, a range of instructional strategies that involves using IT which will facilitate and enhance the learning of the students.

Facilitator of learning

- Able to facilitate the learning of the students in areas such as communication, accessing information, development of thinking skills and problem-solving skills, fostering of creativity, self-directed, cooperative and life-long learning, positive attitudes towards IT, and awareness of related equity, legal, ethical and social issues.

General professionalism

- Be aware of the use of IT to support self-learning, co-operative and life-long learning.
- Be aware of equity, legal, ethical and social issues in relation to the use of IT in education.
- Be aware of the current and future trends of IT and its applications in education.

In the context of these key attributes, the IT competency of a teacher can be further described at each of the four levels, Basic, Intermediate, Upper Intermediate and Advanced:

Basic Level:

At the Basic Level, a teacher needs be aware of the instructional, learning and management roles of IT in education, the changing roles of teachers and students including a teacher's new role as a learning facilitator,

and related equity, legal, ethical and social issues. A teacher needs to have basic skills and knowledge in the operations of computers and readily available educational courseware, and using simple features of tools such as word processors, Web browsers, presentation and e-mail software in education.

Intermediate Level:

At the Intermediate Level, a teacher will be able to make use of a wider range and more sophisticated features of IT tools in education, able to integrate these IT tools into learning and teaching contexts effectively, make better use of resources available on the Internet and Intranet, and able to evaluate simple IT-related educational resources such as readily available educational courseware.

Upper Intermediate Level:

At the Upper Intermediate Level, a teacher will be able to handle daily operations of computer networking, resolve simple hardware and software problems, integrate IT into learning and teaching proficiently and critically, and make effective use of authoring tools for lesson and educational resource preparation.

Advanced Level:

At the Advanced Level, a teacher should have an insight of the current and future trends of IT in education and integrating IT across the curriculum, and the core capability to advise the school on the formulation, implementation, management, monitoring and evaluation of its IT plan, including its hardware and software resources, staff development and support in IT, and promotion of IT culture in the school. In addition, a teacher can choose to develop in the areas such as designing of educational courseware and Web-based resources, multimedia production and presentation, database management system, and the conduct of a project in IT in education.

Further information about these levels of IT competency can be obtained at the following URL:
http://itined.ied.edu.hk/Itcompetency.htm

This study also proposed a set of professional development strategies for the Hong Kong teachers in relation to the application of IT in education. Based on a review of the various strategies in a number of countries, it was suggested an eclectic model comprising a number of methods that suits schools individually and the general situation in Hong Kong context would be appropriate. This is largely based on the consideration that the methods used must suit the needs of the schools by providing the necessary flexibility to the schools and the teachers.

There were three main strategies suggested. They were: school-based professional development; the use of hub-schools and centrally-approved providers.

School-based professional development was one strategy favoured by a large number of experts. The reason was partly related to the contextual professional development that could be related to the work situations of the teachers. Also, the cost of such professional development could be reasonably low compared to teachers having to spend time to travel substantial distance to attend courses elsewhere.

The research team understood from our consultation that virtually all secondary schools in Hong Kong have sufficient expertise to conduct school-based professional development at the basic level and beyond. Some primary school will have difficulties but it was suggested that external consultants could be brought in to assist such professional development.

The use of hub-schools could help to overcome some of the problems associated with school-based professional development such as isolation and lack of expertise and resources within individual schools. The hub school concepts requires the identification of a hub school within a cluster of school. Often, this school has some reasonably good IT facilities that could be utilized for the professional development of teachers to use IT. Also, based on overseas experience, the existence of knowledgeable and enthusiastic individual teachers could help to "maintain" the operations of hub schools for professional development purposes.

The research team also recommended that the Government should establish a list of government-approved professional development providers so that when schools do not have the expertise to conduct these activities, these providers can fill in the gaps. This was especially important for professional development

involving more complex IT skills and educational concepts.

In addition, the research team also recommended that a number of issues be considered when devising the appropriate professional development programmes for the teachers. These issues included: Emphasis on self-learning, availability of optional elements for teachers, activities that model more contemporary thinking on the use of IT in education, project-based learning, flexibility and modularization in the organization of development activities, credit-bearing, promotion, time-release and continual support for the teachers.

In this project, the research team was also required to recommend on the assessment methods used in gauging the IT competency of the teachers. Having examined the practices in many other countries, having consulted with the local and overseas experts, the team decided that the best way would be the use of portfolios. Each teacher would be required to produce a portfolio for each level of IT competency as described above. The use of portfolios for assessment in teacher education supports the current emphasis on meaning in learning and the need for the learner to adopt an active role in the learning process [8]. This supports the strong view expressed at the focus group meetings, that is "Assessment should be on whether they [teachers] can apply contents to their teaching subject in the context of the school". It is the informed view of the research team that through the use of portfolio assessment, then teachers' application of IT in education can be properly and authentically gauged. Also, from the perspective of teacher enablement and empowerment, the use of portfolio with the application of IT in real learning and teaching contexts can encourage the teachers to apply what they have learnt during professional development.

5 Conclusions

To conclude, the research team provided more detailed descriptions of the four levels of IT competency, recommended training contents and strategies as well as assessment. It is pleasing to report that the Hong Kong government has now accepted the recommendations by the research team. Large-scale professional development activities are now taking place for the teachers in Hong Kong. Many schools are conducting their school-based professional development activities, some with the help of eight government-approved professional development providers. With funding from the government on hardware and software installation, we are beginning to witness some massive educational reforms in Hong Kong as a result of the IT revolution.

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Present State and Future Direction of Woman Informatization Education in Korea

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An informatization society, where high added value can be created through networks is different from an Industrial society where physical labor predisposes discrimination between men and women. As knowledge and information are regarded as the most important resources in an Informatization society, intelligence and emotional ability are given more importance than physical superiority. In light of this, the roles and positions of women are being newly evaluated, and the direction of the women's informatization movement has emerged as a new topic of the era. Korea places a strong emphasis on education and the percentage of women who attend University is also high. Contrary to this, the percentage of highly educated women who become working members of society is very low. These days, this problem has been recognized and education in woman informatization has actively proceeded. Taking various kinds of women's organization as the principal axis, woman informatization projects are actively unfolding. Government has also explored supporting plans in various aspects. This study explores the present state of women's informatization education and it's future direction.

Keywords: **Woman Education, Informatization Education**

1 Introduction

An Informatization Society is expected to be the 3F era: Female, Feeling, and Fiction. Productivity of culture and emotions is more important than labor productivity. Instead of labor productivity, sensitivity and intuition unique to women are expected to contribute a lot to the development of an emotional business that has high added value.

As the roles and position of women are newly evaluated, the direction of the women's informatization movement is emerging as an important topic. As it becomes necessary to have women's informatization education in Korea, a new movement has emerged. In light of this, this study will explore the present state and future direction of informatization education of women in Korea.

2 Present State and Problems of Woman Informatization Education in Korea

The studies on women and the informatization society have been introduced in Korea since the end of 1980. Until now, works on the development of women in an informatization society have been produced intermittently. The Korean Women's Association and National Women's Convention has dealt with "Woman and Informatization Society," and attracted the attention of the society of women overall. However, systematic, continuous and comprehensive studies on women and informatization have been insufficient. Also insufficient are the studies on the concrete policy alternatives for informatizing all women in accordance with national informatization.

2.1 Present State of Women's Informatization Education

Korean Women's Development Institute (http://kwdi.re.kr/)
·Government investing research institute ·Constructs public database first in Korea in 1995. ·Systematizes the professional information related to women and provide it by PC communication network ·Construct total distribution management system on woman information and Internet service in 1997
FemiNet Korea (http://www.feminet.or.kr)
·Established in 1996 with the purpose of 「Woman Informatization」 ·Study on woman informatization, education, information culture business, operation of web-site ·Campaign on home informatization
Women Link (http://www.womenlink.or.kr)
·As professional woman movement organization, promote woman informatization ·Explore business to urge woman participation ·Plan the construction of DB on woman information
Asian Pacific Women's Information Network Center, Sookmyung Women's University (http://apwin.sookmyung.ac.kr/)
· Explore woman informatization project most actively among woman organizations attached to universities ·Construct Web-site in 1997 and provides information related to woman ·Hold international seminars · Obtain professionalism by connecting with other inside institutions attached to university including cyber institute ·Obtained the position of Chair of UNESCO · Play a role as main organization in woman informatization in Asia-Pacific regions including Korea and Japan.

<Table 1> Web site of representative women institutes

First, in the case of education, several women's organizations and social education centers for women hold basic computer training and some job training programs and lectures to expand the mind-set for informatization. However, the lectures are sporadic and temporary, and job training programs are limited to extremely small areas, and the content of training focuses on PC utilization, since it doesn't have the fundamental environment necessary.

Among informatization education at government levels, the women's professional training project of the Ministry of Information and Communication has been most systematically promoted. To solve the manpower problems and to nurture women professionals in the multi-media and content fields, the Ministry of Information and Communication has carried out various supporting projects since 1998. The main projects are shown below:

2.1.1 Support Educational Institute Attached to Women's Universities

This project is to support educational institutes attached to Women's Universities with educational expenses. Women university students and unemployed women will be intensively trained in the fields of information communication including S/W programming, system engineering, networking, and game · animation · media in prestigious education institutions exclusively for women, to get a job or open their own business.

2.1.2 Support 'The House of Working Women'

It also supports the education expenses of the House of Working Women. Homemakers and ordinary women can take training courses in the field of information and communication to get a job in the House of Working Women which has its own childcare center.

2.1.3 Support the Foundation of the Business Incubation Center of Women's Universities

To solve unemployment and to activate the foundation of businesses by women professionals, it supports the establishment of the Business Incubation Center in women's universities. With this project, about 16,000 students and homemakers have obtained information training in 1998, and about 250 woman professionals have established their own businesses.

2.1.4 Present State of Information Service and DB Building on Woman Informatization

Centered on a few women organizations and women research centers attached to universities including the Korean Women's Development Institute, FemiNet Korea, Asia-Pacific Women's Information Network Center, Sookmyung Women's University, women-related DB building and information services have been actively promoted. All these institutes have created the environment for women informatization based on the construction of N/W as an information infrastructure, and launched related education, culture and promotional projects.

In detail, 9 women's organizations out of 117, and 5 women's research centers out of 12 attached to universities that can operate social education programs besides the Korean Women's Development Institute, have operating Web Sites. Following are 4 organizations whose activities are the most active.

2.2 Problems in Woman Informatization Education in Korea

In Korea, accessibility to information devices is extremely different between genders. This difference of opportunity results in that of informatization and further causes severe inequality between genders as it becomes an informatization society.

A survey on Internet users by a Korean newspaper showed that the ratio of males to females among Internet users has largely changed. While the ratio of males to females from 1st to 3rd survey was 9:1, the 4th survey showed that female users had largely decreased the ratio discrepancy to 8.15: 1.85. Compared with the gender ratio among world Internet users (6.64 :3.36), that of Korea is found out to have a severe imbalance as ever[4].

Following is the concrete explanation of the problems of woman informatization in Korea[2].

First, the index of woman informatization is relatively low. Especially, that of homemakers was very low. Considering that the household is the basic unit of the nation, and responsible for enforcing social values through the supervision of the homemaker, it is a very severe problem.

Second, the number of women in higher professional training programs is decreasing, even though information training for woman at the regular or temporary training institutes is increasing quantitatively. As well, the professional training courses by temporary training institutes focus on the simple practice-oriented short-term training, reenacting the isolation phenomenon of women labor.

Third, in spite of the quantitative increase in informatization training for women, the number of women working in the information industry is being reduced. Information communication requires professional training in most fields, and it is necessary to make working environments in which women can continue to work and get in-service training even after getting married and having children.

3 Development Direction of Woman Informatization Education

With the advent of the informatization society, job areas divided by gender lost meaning, and accordingly women manpower can contribute to the development of society more and more. Unless fixed ideas on gender roles are discarded and replaced with a flexible way of thinking, the information estrangement of woman will become larger, and result in the loss of one axis of social development[6].
We will explore the development direction of informatization training of woman in the 21st century from this aspect.

3.1 Primary and Middle School Education

We would like to present the desirable direction of informatization education for girl students as follows:
First, school education should implement systematic education of information and provide as many opportunities as possible to allow girl students access to informatization education. Schools should also guide interest and instill a sense of closeness in information technology fields through the information technology related future course guidance after graduation.

In addition, the curriculum should be reorganized to make the most of information devices in each subject. Especially, careful attention should be given to organizing the education courses, so as not to isolate girl students, including elective courses only for girl students. Going one step further, information technology should be actively utilized in girls' elective courses including housekeeping and home economics courses, which will result in natural information education.

Second, the interest of girl students should be attracted to information through various activities including information contests for girl students. Excellent students should be picked out early and guided. Before determining whether the low index of woman informatization is inborn or learned, it is judicious for the government to give the highest consideration to the informatization of girl students in the education system.
Third, information education should be presented to the parents of those girl students who guide them at home. After all, home is the starting point and the last stop of education. An Information-oriented mind-set for students can be decisively affected by their parents. Especially, the informatization education of the parents of primary students has a high possibility to produce positives effect for the students. Accordingly, it will have a profound meaning in terms of education to provide informatization education which parents and students can participate in together.

Fourth, industrial-educational cooperation should be constructed for the education of girl students. Informatization education requires high-priced equipment and high quality personnel due to its character. It is difficult to say that hardware and software infrastructure for informatization education has been established in Korea. However, universities and industries have both foundation facilities and human resources, and as a result, the personnel trained at universities can be regarded as the consumer and beneficiary. Accordingly, the industrial-educational cooperation will result in an effective system for improving the quality of the informatization education and those institutes.

3.2 Policy Direction for Woman Informatization Education

We would like to present the desirable policy direction for the informatization education of women.

First, it is necessary to carry out education of women's problem at an early stage. Informatization education of women is to overcome the imbalance and irrationality that has emerged from gender discrimination. Accordingly, early education of women's problems should be carried out to enable them to overcome the sense of gender discrimination from the juvenile period, and help them with fundamental problem-solving.

Second, it is necessary to select the institutions or women organizations that can act as an axis of informatization education for women, and to allow them to play pivotal roles in that education. At present, many women's organizations have actively carried out and yielded some fruit. However, in reality, there is no center of woman informatization education that can collect the capabilities of many women's organizations. Informatization centers should be selected, networks by region and by institution should be created, and systematic and reasonable informatization education of women should be carried out. This network should also be expanded as an international organization through the Internet.

Third, it is necessary to rearrange and complement the education courses to connect school education to life-time education. For this purpose, education courses for the informatization education of girl students should be rearranged, which should result in systematic and hierarchical life-time education.

4 Conclusions

Due to the special nature of the information industry, women's labor power of processing and creation of knowledge has retained a new evaluation. Women's delicate nature, intellectual power, and creativeness herald the creation of new value. The emergence of new jobs and concepts of working places opens the new horizon for the possibility of the woman labor force. What is important here is, however, not to be satisfied with this possibility, but to turn this possibility into reality.

Educational fever in Korea is relatively high. The rate of women who go to universities is very high. Compared with those of advanced countries, however, less women with high education have made their way into the society, and as a result, the education for women remains as the consumptive type of education.

It is time to discard the view that the informatization education of women is just one area of expansion of

women's right. Korea has to recognize the importance of utilizing the tremendous number of potential women laborers as real available manpower, and to put a large investment and sufficient support into this.

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Space Plan for Effective Educational Software Utilization in Korea

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Need of the ICT(Information & Communication Technology) based education has been emphasized and importance of educational software is being recognized, but it is not being utilized effectively. To solve this problem, we surveyed present conditions, recognition, and obstructive factors of educational software utilization for teachers of elementary schools, junior high schools, and high schools, and school inspectors who use educational software in their schools by questionnaire and interview. On the basis of the surveyed matters, we suggested a plan to utilize educational software effectively in the teacher, educational software, support system, and environment side.

Keywords: **Educational Software, Effective Utilization**

1 Introduction

1.1 Purpose

The key target of the educational informationalization business in Korea is to improve methods and quality of teaching and learning by using various educational software. For this, total 3,400 educational software have been developed and distributed in Korea from 1985 to 1998, and software purchase expenses of 1 million won per school have been supported from 1998 to use software developed by private hands.

Although lots of software are being distributed to each school like this, rate of teachers who have used educational software is lower than expected and schools continuously appeal lack of educational software. But definite and objective factors of why educational software is not used properly have not been found.

Therefore, a realistic and practical plan for effective educational software utilization should be prepared for teachers in their schools by finding problems and actual conditions based on development, distribution, and utilization of present software and gathering opinions of demanders and suppliers of educational software.

1.2 Content and Methodology

This study surveyed the followings by questionnaire and interview[1].

First, Present conditions of educational software utilization. Second, Recognition of educational software utilization. Third, Obstructive factors to educational software utilization.

The subjects of questionnaire were 1568 teachers of 128 schools(8 schools of each two elementary school, junior high school, academic high school, and vocational high school under the Education Administrations of national 16 cities/provinces were selected). Especially, for the above Third matter, interview was added for school inspectors in charge of educational informationalization, chiefs of the information department and teachers in charge of the task in the 9 Education Administrations.

2 Concept and Category of Educational Software

The educational software may be wholly utilized in the education and educational support field.

Jeong Taek-hee et al. define educational software as 'data or program that are directly inputted to a teaching-learning course and mediate interaction between teachers and learners to achieve the educational object'[2].

This study focused on data or educational software made for teaching-learning and set the concept of educational software as "software with teaching-learning purposes of a diskette, CD-ROM, and web type, containing educational matters made with each kind of authoring tools or programming languages". Also, presentation and digital encyclopedia type, which are being used a lot in the field, are included in it.

3 Analysis of Educational Software Utilization

The questionnaires were recalled from 84 schools among 128 schools which received them and the recall rate was about 65.6%. But among them, 6 schools respond unfaithfully, so questionnaires for just 78 schools were handled, the response rate was about 56.7% consequently.

3.1 Present Conditions of Educational Software Utilization

As a result of questionnaire, it was surveyed that 67.8% of respondents have used educational software during the class. But it is just 1 time use and most teachers responded that they did not utilize it now.

Enough	Over 70%	Over 50%	Under 50%	Under 30%	Almost not utilizing	No response	Total
34(4.6)	32(4.3)	66(9.0)	0(0)	65(8.8)	471(63.9)	69(9.4)	737(100)

<Table 3-1> Degree of educational software utilization

The results of surveying reasons for not utilizing(for intending not to utilize) educational software are as <Table 3-2>.

Place	Reason for not utilizing
1	There is no proper educational software.
2	It is not suitable for curricular characteristics.
3	It is thought that there is no special need.

<Table 3-2> Reasons for not utilizing educational software

3.2 Will of Utilization of Educational Software

It was found that respondents who responded that they had a plan to utilize educational software were far more than respondents who had responded that the had not to the question, "Will you use educational software in future?". So it shows that the will of teachers to utilize educational software was significantly high.

Yes	No	No response	Total
453(61.5)	61(8.3)	223(30.2)	737(100)

<Table 3-3> Will you utilize educational software in future?

The reasons for having a plan for software utilization are first, increase of educational efficiency, and second, improvement of teaching quality, and other responses were attraction of students' interests, improvement of a visual effect, and playing a role of a teaching helper.

3.3 Obstructive Factors to Educational Software Utilization

The fact that there is a will to utilize educational software but it is not utilized involves many suggestions. This study considered it as an obstructive factor to educational software utilization and surveyed it by interview. The reason for using interview instead of questionnaire was for consideration of the field conditions which cannot be expected by questioners.

3.3.1 Hardware

(1) Inadequacy of Hardware Environment: To utilize educational software, specifications of hardware should be good. A student has a computer as the level of a computer per 15.8 students including from 286 grade to pentium grade and as the level of a computer per 19.1 students in case of efficient over pentium grade for utilization in Korea. This can be sufficient basis to raise consistent voice for field teachers, 'hardware environment is inferior'.
(2) Inferior Maintenance System: Computer produces various maintenance conditions such as from software error to exchange of computer mainframe. But present condition is that teachers are not sufficient to decide correctly and cope with these conditions.

3.3.2 Educational Software

(1) Lack of Utilization Capability of Educational Software in a Class: There were many opinions that they fall in utilization as an intention of educational software developer is not the same as the intention of teacher in a class. And, it was appeared that it is difficult for the software to connect with curriculum as reconstructing of educational software is difficult.
(2) Lacked Information about Educational Software: When teacher wishes to utilize educational software in a class, information to guide him are so insufficient. This functions as a factor to refuse the utilization of educational software by teacher as well as work excess of teacher.

3.3.3 Teacher

(1) Lack of Utilization Ability and Absence of Practical In-service Training: To utilize educational software effectively, teacher must have the ability to connect the contents of educational software with instruction contents. In-service training can be an appropriate method to improve this ability. But In-service training executed now includes mainly learning of fundamental ICT or development of educational software rather than utilization of educational software.
(2) Lack of a Study Time of Teaching Materials: To apply the educational software on a class in the school field, teacher must confirm the hardware environment, understand the contents and type of educational software by checking, and has an ability to reconstruct the contents of class. He must check various things himself as there are no sufficient existing information for utilization and there is nearly no place to ask. However, it was appeared that teacher did not utilize educational software as his task is so much for these works.

4 Utilization Plan of Educational Software

We examined recognition of teachers, actual condition of utilization, and obstructive factor about educational software as mentioned above. In this study, we will prepare a plan to settle obstructive factors educational software effectively and practically on the basis of this.

4.1 Hardware

We will suggest the plan for hardware as the consideration of 2 conditions such as exchange of the existing old computer and new installation. And other various conditions must be considered for current educational software. In consideration of these condition, gradual plans of the following 3 steps are necessary.
First, basic utilization must be induced by distributing multimedia PCs in classroom primarily. Second, multimedia room must be installed by each school with the first step together. It is because that multimedia room can be utilized for storage of educational software, role of file server, and development of educational software. Third, installed hardware is required to maintain certainly and to reinstall. To ensure the continuous maintenance and reinstallment for hardware can give sense of stability to the school and extend efficient utilization of educational software.

4.2 Educational Software

To utilize educational software efficiently, most of all, educational software with good quality must be developed and distributed in the school field. In addition to the development of educational software with good quality, P.R. about developed educational software is necessary urgently. We suggest plans in

consideration of these conditions as follows.

First, DB on the development educational software must be provided by the level of Ministry of Education. DB must arrange and construct contents to be a standard of selection such as subject, type, and characteristics about each educational software when teachers wish to utilize educational software. Second, educational software must be manufactured with easy type for utilization in a class and its development breaks from the form of collection. And it must be manufactured as a form with easy change of structure according to the class intention of teacher. Third, educational software must receive financial support to evaluate the quality of educational software, which is developed by a private enterprise, and to purchase and use it if it is excellent educational software.

4.3 Teacher

First, in-service training about practice of educational software must be performed. In U.S., State of California performs a in-service training to raise practicable ability educationally in the second step, the level of teaching, of teacher training course[3]. In Korea, the school field also indicates problems of the existing training and requires the training of this level. To supplement problems of the existing training and change it for practical training, first, what part is considered to be the most difficult for teachers must be examined when they intended to use the educational software. And we must analyze hardware problems and software problems met in running educational software and must perform a training about countermeasures against these error conditions to teachers. Especially, we must improve the ability of educational software selection as we let them evaluate educational software and let them apply it on a class during in-service training course.

Second, we must give study time of teaching materials to teacher for utilizing educational software as aiming at efficiency of work by arranging school management and administrative structure. And on the basis of studied contents, we must make a mood to study teaching materials for teacher by giving advantages such as allowance and promotion marks to teacher who carries out developmental class.

4.4 School Support System

In our country now, policies applied on education are made by policy investigators after examination of various facts and then are instructed collectively. To be sure, they provide results of study to the other school by study exemplary school, but practical results of study are not gained due to the lack of source of revenues and manpower. It is also applied in suggesting efficient settlement plan about educational software. To settle these problems, the study composed by following 4 steps must be performed continuously.

First, investigate facts indicated as problems in the school field concentratedly. Second, understand practical problems by analyzing investigated contents. Third, prepare settlement plans for practical problems. Fourth, apply this on the system.

4.5 Reorganization of Curriculum

Great vast digitalized data are being produced due to the development of ICT and the acquisition is possible easily. If students want and try, they can utilize base environment, which has already been prepared, to be able to acquire great information than teachers. Under these environments, it is required to learn method and experience to produce valuable information by utilizing knowledge than committing to memory of knowledge simply. This shows that it is required to reconsider what we teach in the school field. But as current curriculum is knowledge-centered curriculum and ICT is accessed with only simple support level for progress of class, difficulties of teachers have been added a load. Therefore, to aim at efficiency of practical education, curriculum must be reorganized for integrating ICT into education. This means that ICT must not play only a supporting role of education but be a base of education[4].

5 Conclusion

As modern society became informationalization society and knowledge based society, the amount of information increases rapidly and its life is short. Students must live in these society conditions and school must grow society adaptability of students. Currently computer is discussed on the same level of reading,

writing, speaking. In these flow, the importance of educational software has increased. Utilization of educational software enables not only to progress efficient class but also to extend ICT applicable ability of students. But the utilization of educational software is greatly lower than necessity of educational software. To settle this problem, it is required of curriculum and teaching method met with information society and ICT must be not supporting means of education but a base of education. And, first of all, an important thing is field teachers. Systematic support is required to utilize educational software for field teachers and effort of teacher itself is required.

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Using Learning Object Meta-data in a Database of Primary and Secondary School Resources

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The Learning Object Meta-data (LOM) is an emerging standard for annotation of educational entities (digital or nondigital) that are relevant to technology-supported learning. The annotations describe educational, legal, and technical characteristics of these resources. The IEEE Learning Technology Standards Committee sponsors development of this standard. In this paper we describe an application of the LOM to the construction of a database of resources available to schools in Hawai'i, and report on both successes and issues encountered. Recommendations are made concerning modifications to the LOM and adoption of the LOM by others working in primary and secondary school contexts.

Keywords: **Standards, Meta-data, Resource Databases**

1 Introduction

Internet technology for learning, including web-based resources, networked groupware and remote sensing have the potential to bring teachers and students together with a greater diversity and quantity of human, natural and technological resources than was previously possible. Educators and students can now access an enormous variety of web-based expository materials, images, activity plans, simulations, etc., and interact with people from many walks of life over the Internet. Already pressed for time, how will educators sort through this cornucopia of information and misinformation and find the resources appropriate for the educational needs of their students? Clearly, in order to leverage the great potential of this de-facto worldwide digital library, educators will need help. This paper is concerned with one form of help: databases of *meta-data* or information that describes the relevant characteristics of educational resources sometimes called *learning objects*. Properly constructed meta-data databases that have interfaces designed to match educator's perspectives should enable them to find relevant learning objects more quickly.

There are two other factors that also motivate this work. In the United States, there is currently a strong emphasis on systemic reform in public school education at the primary and secondary school levels. Being *systemic*, this movement is encouraging and compelling a greater diversity of stakeholders to collaborate in their mutual interest in supporting achievement of high standards in the schools. For example, the Educational System Reform (http://www.ehr.nsf.gov/EHR/ESR/) division of the US National Science Foundation requires that proposals for funding show evidence of significant collaborations between schools, universities and colleges, business and industry, and other community members in genuine support of sustainable reform (i.e., reform that continues beyond the funded period). As a result, organizations and individuals who have not previously worked together need to become aware of the resources they offer to each other. Hence databases of resources that are tailored for particular locations are needed. The present work is one example of such a database.

A third motivating factor is economic. The cost of building educational materials, particularly technology-supported materials such as software, is high. All too often, persons and groups who are intellectually prepared to develop innovative new approaches to the application of technology to education spend most of their time rebuilding basic functionality. Recent interest in educational object repositories and educational

technology standards is motivated in large part by the desire to be able to find and reuse the work of others. Standards are being developed to describe learning objects [5] and to facilitate the interoperability of these objects once they are found [3]. This work is concerned primarily with standards for describing learning objects so that they may be found. Software interoperability has been addressed elsewhere (e.g., [2, 6]). Standards for describing learning objects also address economic issues surrounding resource databases because databases are expensive to build. Rather than replicate existing meta-data, it is preferable to access existing meta-data repositories. However, this requires standard forms for meta-data.

In summary, these forces require educators and their partners to be aware of the diversity of resources that are potentially available to them and to understand the significance or potential utility of these resources with respect to educational objectives. Resource databases should adequately describe a diverse variety of resources yet relate them all to common educational objectives, describe the resources in terms understandable to educators, and interoperate with other major repositories. In this paper we report on our first efforts to design such a resource database to meet these needs within the State of Hawai'i as part of a systemic initiative known as Hawai'i Networked Learning Communities. Specifically we report on our use of an emerging standard, the Learning Object Meta-data (LOM). The paper provides a brief introduction to the LOM, describes its application to HNLC, and discusses limitations and extensions to the LOM that were required. Finally, readers are provided with information on how to participate in the development of the LOM.

2 Background

2.1 Learning Object Meta-data

Meta-data, simply defined, is data about data [4, 7]. Meta-data defines the characteristics of other data so that it may be interpreted and used intelligently. In this sense meta-data enables us to use data as *information*. The phrase *learning object* is used to inclusively denote a wide variety of entities used to support learning, including but not limited to digital resources such as software, multimedia, or hypertext, and nondigital resources such as courses of study, professional development programs, or persons who have volunteered to serve as mentors. Assembling these concepts, we come to *learning object meta-data*, which is somewhat of a misnomer in that the meta-data is not only describing data, but also other entities that are not data (such as persons). Yet the term "meta-data" is already in wide use for this purpose, so will be used herein.

2.2 Technical Standards

A *technical standard* is a specification of shared terms, interfaces, representations, practices, etc. If an artifact (such as computer or networking hardware, a software program, or data representations) is constructed to be compliant with a technical standard, then that standard ensures that multiple stakeholders will be able to interpret or interface with that artifact without needing to ask for help from the creator of the artifact. That is, a standard helps ensure interoperability and reuse. A standard is expressed in a document that sets forth the scope and purpose of the standard and the mandatory conditions for compliance. The existence of a standard, e.g., for learning technologies, does not mean that everyone is expected to comply with the standard. It only sets forth the conditions for those who elect to claim compliance with the standard.

2.3 The IEEE LTSC Learning Object Meta-data

The IEEE (Institute of Electrical and Electronics Engineers, http://www.ieee.org/) is an international organization for engineers of electrical and information technologies. IEEE has a well-defined standards development process administered by its Standards Activity Board (http://www.computer.org/standards/). The Learning Technology Standards Committee (LTSC), which was founded in 1996 by a group of academic, government, and industry representatives (including the author), chose to use the IEEE standards process for this reason. The LTSC sponsors several learning technology related standards efforts, at various levels of maturity ranging from speculative to approaching balloting. The Learning Object Meta-data draft standard [1] (also known by its IEEE identifier as 1484.12) is arguably the most mature of the LTSC draft standards. According to a recently circulated revision to the Project Authorization Request, "The purpose of this standard is to facilitate search, evaluation, acquisition, and use of learning objects, for instance by learners or instructors. The purpose is also to facilitate the sharing and exchange of learning objects, by enabling the development of catalogs and inventories, taking into account the diversity of cultural and lingual contexts in which the learning objects and their meta-data will be exploited."

The LOM standard is meant to provide a semantic model for describing properties of the learning objects themselves, rather than detailing ways in which these learning objects may be used to support learning. The LOM indicates the legal values and informal semantics of the meta-data elements, their dependencies on each other, and how they are composed into a larger structure. It is intended to be extended, and in fact a structure has been provided specifically for the purpose. The LOM is agnostic concerning *bindings* or implementations of meta-data in particular representations or notations, such as XML. (At this writing, a study group is exploring a separate XML binding specification.) No particular representation or implementation is specified or implied by the LOM. Systems that are LOM compliant may present users with any interface they wish and store the meta-data however they wish. The LOM specifies only the semantics of the meta-data in order to enable meaningful interchange of meta-data between systems.

An outline of the LOM meta-data elements as of draft 4.1 [1] is provided in Table 1. In this table, nesting indicates a compositional relationship. For example (adopting notation commonly used in the LOM committee), a single 1.3:Catalog.Entry consists of a 1.3.1:Catalogue and an 1.3.2:Entry; while a 9:Classification consists of several types of sub-elements, some of which themselves also have internal structure. Much important information has been left out of this table for space considerations. For example, some data elements may take on multiple values which may be ordered or unordered, and some must be taken from restricted vocabularies or reference other standards for their values.

Table 1 Outline of Learning Object Meta-data Elements

- **1 General**
  - 1.1 Identifier
  - 1.2 Title
  - 1.3 CatalogEntry
    - 1.3.1 Catalogue
    - 1.3.2 Entry
  - 1.4 Language
  - 1.5 Description
  - 1.6 Keywords
  - 1.7 Coverage
  - 1.8 Structure
  - 1.9 Aggregation Level
- **2 LifeCycle**
  - 2.1 Version
  - 2.2 Status
  - 2.3 Contribute
    - 2.3.1 Role
    - 2.3.2 Entity
    - 2.3.3 Date
- **3 MetaMeta-data**
  - 3.1 Identifier
  - 3.2 Catalog Entry
    - 3.2.1 Catalogue
    - 3.2.2 Entry
  - 3.3 Contribute
    - 3.3.1 Role
    - 3.3.2 Entity
    - 3.3.3 Date
  - 3.4 Meta-data Scheme
  - 3.5 Language
- **4 Technical**
  - 4.1 Format
  - 4.2 Size
  - 4.3 Location
  - 4.4 Requirements
    - 4.4.1 Type
    - 4.4.2 Name
    - 4.4.3 Minimum Version
    - 4.4.4 Maximum Version
  - 4.5 Installation Remarks
  - 4.6 Other Platform Requirements
  - 4.7 Duration
- **5 Educational**
  - 5.1 Interactivity Type
  - 5.2 Learning Resource Type
  - 5.3 Interactivity Level
  - 5.4 Semantic Density
  - 5.5 Intended end user role
  - 5.6 Context
  - 5.7 Typical Age Range
  - 5.8 Difficulty
  - 5.9 Typical Learning Time
  - 5.10Description
  - 5.11Language
- **6 Rights**
  - 6.1 Cost
  - 6.2 Copyright and Other Restrictions
  - 6.3 Description
- **7 Relation**
  - 7.1 Kind
  - 7.2 Resource
    - 7.2.1 Identifier
    - 7.2.2 Description
    - 7.2.3 CatalogEntry
- **8 Annotation**
  - 8.1 Person
  - 8.2 Date
  - 8.3 Description
- **9 Classification**
  - 9.1 Purpose
  - 9.2 TaxonPath
    - 9.2.1 Source
    - 9.2.2 Taxon
      - 9.2.2.1 Id
      - 9.2.2.2 Entry
  - 9.3 Description
  - 9.4 Keywords

Brief descriptions of the major element categories follow. *1:General* provides information such as title, a brief textual description, and keywords. *2:Life.Cycle* describes the development and current state of the resource. *3:Metameta.Data* describes the meta-data itself, e.g., who entered or validated this meta-data instance and what language it is written in. *4:Technical* provides information on media type, size, software requirements, etc. for those learning objects to which these attributes apply. *5:Educational* is intended to provide basic information about the pedagogical characteristics of the resource. This category includes some of the most controversial elements, to be discussed further below. *6:Rights* describes the conditions under which one may acquire and use the learning object. *7:Relation* is intended to describe the learning object in relation to other learning objects. At this writing there is a controversy concerning whether this may be used to control sequencing of a collection of learning objects, or whether that should be deferred to other standards being developed for the purpose. *8:Annotation* allows for the accumulation of comments by persons who have used or are otherwise evaluating the learning object. *9:Classification* provides a means of extending the LOM to meet specialized needs. 9:Classification comes in the form of a generic structure for classifying the learning object in one or more taxonomic systems external to the LOM. Most of our extensions used 9:Classification.

3 HNLC Resource Database

The remainder of this paper describes our first prototype design and implementation of a learning object resource database, specifically focusing on the use of the LOM as a guiding framework for the design, and on ways in which extensions to the LOM were required. I briefly describe the initiative that this database was intended to serve before discussing the application of the LOM itself.

3.1 Hawai'i Networked Learning Communities

The Hawai'i Networked Learning Communities (HNLC, http://lilt.ics.hawaii.edu/hnlc/) initiative is a partnership between the Hawai'i Department of Education (HDOE), the University of Hawai'i, and many other stakeholders in the quality of Hawai'i public education, such as business and nonprofit interests. HNLC's purpose is to prepare all students in Hawai'i's public schools for life and careers in today's world by enabling them to attain high standards in science, math, engineering and technology (SMET) education. The HNLC initiative is supporting HDOE in its systemic standards-based reform efforts by leveraging Hawai'i's rich land, sea, space, and cultural resources. A theme of "global environmental studies, situated locally" pervades the work. From the standpoint of technology-supported learning, HNLC has three major thrusts. First, professional development will help educators make better use of technologies as educational resources in their classrooms. Second, distance collaboration and remote sensing technology will bridge the distances between small rural schools and the islands' rich resources, enabling virtual access to field sites, research laboratories or equipment, and, most importantly, peers and mentors of students, teachers and others involved in the educational process. Third, a web-accessible database will address one of the most frequent requests encountered during our needs assessment: knowing what resources are available to educators in Hawai'i. This paper is about the suitability of the LOM for this database.

3.2 Scope of the Database

The database describes resources for public school education ranging from Kindergarten (K) to 12th grade, also abbreviated as K-12. Standards-based reform is essential to the initiative: hence all resources must be described with respect to the Hawai'i Content and Performance Standards (http://www.hcps.k12.hi.us/), a document specifying what should be taught and how students' learning should be assessed. A wide variety of resources will be described, making this a particularly challenging test implementation of the LOM. For example, the following resources might be included:

- A university program in which Ph.D. students have their expenses paid in exchange for mentoring teachers for a certain number of hours a month. This can take place over the Internet; ideally, the teacher's students become involved in field report in support of the Ph.D. thesis.
- Nationally recognized curricular resources developed at the University's Curriculum Research and Development Group (http://www.hawaii.edu/crdg/).
- A software program with which students can construct explicit visual models of their evidential reasoning while participating in investigations (http://lilt.ics.hawaii.edu/belvedere/index.html).
- A network of autonomous weather stations and remote controlled cameras, to be placed in the Alaka'i swamp (one of the rainiest place on Earth) or Volcano National Park, in some cases with the cameras

trained on individuals of endangered plant species, with radio links to the Internet (http://www.botany.hawaii.edu/pods/).

- A nurse practitioner at a local military hospital who volunteered her time to telementor students on medical topics.
- Malama Hawai'i, a new environmental education project started by the famed Polynesian voyager Nainoa Thompson (http://www.malamahawaii.org/).
- Advanced placement courses in computer science and discrete math, offered by our department to high school students via Hawai'i DOE's Internet-based E-School (http://atr.k12.hi.us/eschool/index.shtml).
- The He'eia Ahupua'a, in which researchers and school children collaborate to study the integration of modern and traditional Hawai'ian land management techniques (Internet collaboration and mentoring is being planned: http://kauila.k12.hi.us/~ahupuaa/).
- A Community College's research grade 24" telescopes, recently displaced from Haleakala by larger telescopes and now being installed for Web-accessible use at the CC. The telescopes are still viable for new asteroid, comet and supernova survey research that can be conducted by high school students over the web, being supervised by college students and their professional mentors.
- Diverse resources for teaching constructed by teachers and made available to others as part of a new product-oriented approach to professional development credits being implemented by HDOE.

All of these fall within LOM's scope of "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning" (from the original Project Authorization Request, http://ltsc.ieee.org/par-lo.htm) because we will be using distance collaboration and remote sensing technology (as well as the database itself) to support learning using these resources. To control the scope of our work, HNLC will prioritize the description of local resources and interface with other repositories for nationally available resources (e.g., GEM).

4 HNLC LOM Meta-data

In designing the meta-data for resources such as those listed above, we found it necessary to extend the LOM. As previously noted, the LOM was designed to be extended. In some cases the predefined LOM elements were adequate, and in other cases we were able to perform the desired extensions using the LOM 9:Classification facility. However in a few cases it was necessary to extend restricted vocabularies (which is not normally allowed), and in other cases structural issues arose. In this section I describe the most significant extensions, including the issues just mentioned.

4.1 Method

Our team consisted of Susan Johnson and Beth Tillinghast (Library and Information Science students), Laura Girardeau (an Environmental Education graduate), and David Nickles (a Computer Science graduate).

Initially Johnson and Tillinghast wrote informal textual descriptions capturing the important information about a representative sample of the resources that we wanted to describe. After reviewing these descriptions I presented the LOM draft 4.1 [1] to the entire team, which required extensive discussions for clarification. We then went through the textual descriptions and identified LOM elements in which the information expressed could be captured. Where we failed to find LOM elements for an item of information we extended the LOM, either by expanding on the vocabulary of an existing element or by creating an entirely new element under 9:Classification.Where new elements were needed we searched other repositories to find meta-data that we could use. Several iterations were required to understand the LOM structure well enough to define our instances of 9:Classification. (It should be noted that end users are not expected to understand the LOM: the LTSC community expects that suitable interfaces will be developed, and no end user will even need to know that the LOM exists. We were approaching the LOM as information professionals, not end users.) Then Nickles created a Filemaker implementation of the resulting HNLC-LOM and provided the others with an interface for building meta-data (Figure 1). Johnson and Tillinghast then created meta-data for our sample. I then reviewed the result to detect possible misunderstandings and issues. I also compiled a first draft of issues and recommendations. This draft was shared with the LTSC LOM committee, both via email and subsequently face to face in an LTSC meeting (Montreal, June 2000). Thanks to their feedback, many issues were resolved or re-understood as non-issues, and many further clarifications resulted.

4.2 Vocabularies

The data type of LOM elements may be primitive (e.g., a string), reference other standards (e.g., vCard), or consist of a controlled vocabulary. In the latter case, the vocabulary may be restricted, meaning that only the terms listed may be used, or open with recommended practice, meaning that one should attempt to use one of the terms listed as the recommended practice but may extend this vocabulary if needed. One extends the vocabulary by using a tuple of form (See_Classification, *term*). The *term* is the new term being added to the vocabulary. One must define an instance of 9:Classification that has the same 9.1:Purpose as the data element being extended, and define a 9.2:Taxon.Path as needed to indicate where the term falls within the taxonomic system indicated by 9.2.1:Source. (A taxon path can be thought of as a sequence of taxons, which begins at the root of a taxonomic hierarchy and works its way down the tree through intermediate nodes to the leaf node under which the object is being classified.)

For example, suppose one wants to extend 5.2:Learning.Resource.Type with the term "Curriculum" taken from the Gateway to Educational Materials (GEM) Resource Type vocabulary, (http://www.geminfo.org/Workbench/Metadata/Vocab_Type.html).
One would place the tuple (See_Classification, "Curriculum") in the 5.2 location, and then construct an instance of 9:Classification with 9.1:Purpose = Learning.Resource.Type, a single 9.2:Taxon.Path with 9.2.1:Source = "GEM Resource Type," and a single 9.2.2:Taxon with 9.2.2.2: Entry = "Curriculum" (there is no ID available).

Although this seems much more awkward than simply using the term "Curriculum" in the 5.2:Learning.Resource.Type field, two points should be kept in mind. First, it is a powerful general-purpose way of extending vocabularies with information about the taxonomic source of the term, and hence its semantics. If we were to simply add a termto 5.2:Learning.Resource.Type its semantics would be inaccessible, as there would be no place to record where the term came from. Second, the LOM information structures are neither specifications of an implementation nor specifications of a user interface: implementations are free to reorgainze the presentation of information to the user as convenient (e.g., to present extensions to vocabularies *as if* they were simply added to the same field in question).

We found several of the LOM vocabularies for 5:Educational to be insufficient for our purposes. In one case, 5.2:Learning Resource Type, the vocabulary was open and the insufficiencies could be addressed via the extension mechanism just described. However, vocabularies for 5.1:Interactivity.Type (values: Active, Expositive. Mixed, or Undefined) and 5.5:Intended.End.User.Role (Teacher, Author, Learner, Manager) are restricted vocabularies, so cannot be extended in this way. We have made the recommendation that these be changed to open vocabularies until better consensus on an adequate term set can be obtained with the help of the various communities expected to be using the LOM.

4.3 Structural Issues

In some cases we felt that the vocabulary should be replaced with a structured description. This was actually the case for 5.1:Interactivity.Type and 5.5:Intended.End.User.Role (see next section), as well as 5.7:Typical.Age.Range. Concerning the latter, K-12 educational resources in the United States are almost always referenced by grade level rather than age range. Other applications may require other measures. Anticipating the need for flexibility, we recommended that 5.7:Typical.Age.Range be changed to a structured element with 5.7.1 Measure (e.g., "Chronological Age," "GEM Grade," etc.) and 5.7.2:Value (e.g., "12," "7-8," etc.).

More problematic are ways in which the value of one element depends on another. We noted that 5.9:Typical.Learning.Time depends on 5.7:Typical.Age.Range, for example, a textbook might be described as suitable for a fast paced graduate course or a two-semester undergraduate sequence. Erik Duval later pointed out that this applies to 5.4:Semantic.Density and 5.8:Difficulty as well. Hence I recommended reorganizing these elements in a manner such as the following:

5.x Challenge Level, consisting of one or more 4-tuples:
- 5.x.1 Educational Level (formerly 5.7), consisting of one or more pairs:
  - 5.x.1.1 Measure (e.g., Age, US Grade, ...)
  - 5.x.1.2 Value (e.g., 7-8)
- 5.x.2 Semantic Density (formerly 5.4)
- 5.x.3 Difficulty (formerly 5.8)
- 5.x.4 Learning Time (formerly 5.9)

Then one could create multiple instances of 5.x: Challenge.Level, with the values of 5.x.2 through 5.x.4 being dependent on the value of 5.x.1:Educational.Level. It is possible to *implicitly* achieve the same effect by replicating entire LOM metadata instances, one for each developmental level (or age); but we feel that it would be far more perspicuous and efficient to acknowledge the dependency explicitly in a structure such as the above.

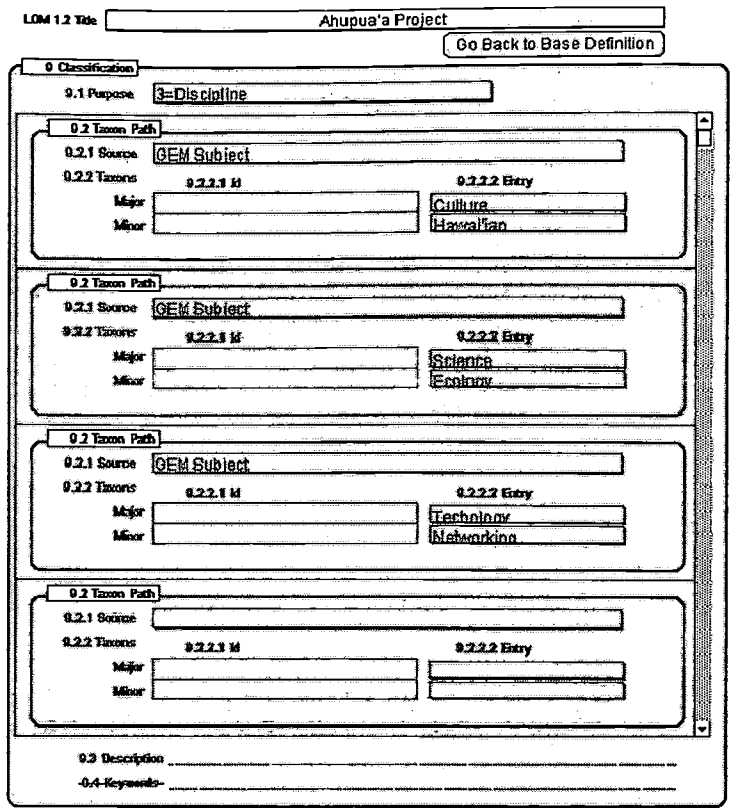

Figure 1. Prototype HNLC Resource Database: a Discipline classification

4.4 Our Extensions to the LOM

The following extensions were made using 9:Classification.

4.4.1 Audience

This extension effectively replaces 5.5:Intended.End.User.Role with the GEM Audience (http://www.geminfo.org/Workbench/Metadata/Vocab_Audience.html), a two-part classification consisting of ToolFor (who uses the tool) and Beneficiary (who benefits). For example, a professional development resource that helps teachers handle learning disabled children in their classes is for the teacher but benefits the particular population of learning disabled students. We would prefer that 5.5: Intended.User.Role be modified to be composed of 5.5.1:Tool.For and 5.5.2:Beneficiary.

4.4.2 Community Involvement

This extension describes how a resource interacts with various stakeholders. We are designing this classification ourselves. We are considering a two-part classification: One for the community entity involved, and the other for the type of involvement.

4.4.3 Discipline

This extension describes the subject matter area covered by the resource. There is presently no LOM field that does this (other than possibly 1.7:Coverage, which has limitations beyond the scope of this paper). We are using the GEM Subject. This is a two-level classification system, requiring a two-step Taxon Path, for example Science/ Astronomy. We found it necessary to add two first-level classifications to the GEM Subject: Technology and Culture. An example using these subjects is shown in Figure 1, a partial screen dump of our Filemaker prototype implementation. We also needed a way to indicate cross-curricular integration. For this we again elected to modify the GEM taxonomy by allowing any major level Subject

header to be listed as a minor header under the subject with which it is integrated. For example, Science/Mathematics would indicate that the resource integrates Mathematics into Science (since Mathematics is normally a Major taxon). For the GEM Subject controlled vocabulary see http://www.geminfo.org/Workbench/Metadata/Vocab_Subject.html.

4.4.4 Educational Level

This extension augments LOM 5.7:Typical.Age.Range, and is structured as described in the previous section.

4.4.5 Educational Objectives

This extension addresses content and performance standards. It is distinct from Discipline because it is more specific: it aligns the resource with the particular standards that the resource is intended to help achieve. Examples of national (US) content and performance Standards include America's Choice (http://www.ncee.org/ac/intro.html); NCTM standards for mathematics (National Council of Teachers of Mathematics, http://nctm.org/standards/); the NSES for science (National Science Education Standards, http://www.nap.edu/readingroom/books/nses/html/), and the National Educational Technology Standards (NETS http://cnets.iste.org/). An example of a state standard is the Hawai'i Content and Performance Standards (http://www.hcps.k12.hi.us/).

4.4.6 Pedagogy

This extension addresses the *severe* deficiency of the LOM's 5.1:Interactivity.Type, a closed vocabulary of {active, expositive, mixed, undefined}. We have recommended that the vocabulary for 5.1 be reopened. However our version provides an even richer description of interactivity, using the GEM Pedagogy controlled vocabulary. This vocabulary (http://www.geminfo.org/Workbench/Metadata/Vocab_Pedagogy.html) has three facets: Teaching Methods (GEM provides a large vocabulary), Grouping (individual, small group, large group, etc.), and Assessment (which is sometimes integrated into the pedagogy).

5 Conclusion

Internet technology for learning, including groupware and remote sensing, have the potential to bring teachers and students together with a greater diversity of human, natural and technological resources than was previously possible. Additionally, the current emphasis on systemic reform in public school education in the United States is encouraging and compelling a greater diversity of stakeholders to collaborate in their mutual interest in supporting achievement of high standards in the schools. These forces require that educators and their partners be aware of the resources that are potentially available to them and to understand the significance or potential utility of these resources with respect to educational objectives. The HNLC Resource Database is being designed to meet such a need in the context of systemic standards-based reform in the state of Hawai'i. The demands on such a database are high: it should interoperate with other major repositories, adequately describe a diversity of resources, yet relate them all to common content and performance standards and generally describe the resources in terms understandable to educators. The LTSC's Learning Object Meta-data (LOM) is being developed in part to lay the foundations for meeting such needs. In this paper I described our attempt to use the LOM for the HNLC Resource Database. We found that it provides a solid foundation in the form of many well thought out data elements as well as a means for extension. We also found that the LOM does not address all the needs of the HNLC Resource Database. This cannot be expected as the LOM is being designed to serve a variety of applications in government and industry as well as public education. We were able to deal with most of the limitations through the Classification method of extension. However some of these extensions were due to premature closure of the LOM vocabularies. More problematic were structural dependencies between LOM elements that are not well captured at present. These issues were illustrated with examples from K-12 education.
The Learning Object Meta-data standard is under active development at this writing. It is hoped that this paper will help increase awareness within the primary/secondary education sector worldwide of the LOM standards effort, and encourage your contribution to further development of the standard to be more appropriate for primary/secondary education needs. Anyone may participate: see http://ltsc.ieee.org/ for details.

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